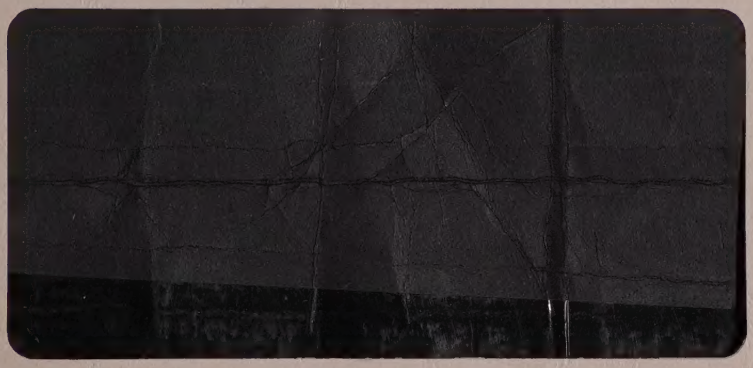

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California Instruments

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P/N 5003-960

801RP / 1251RP Series AC Power Source
User and Programming Manual

User's Manual
AC Power Source
California Instruments
Models :

- 801RP
- 1251RP

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SAFETY SUMMARY

This power source contains high voltage and current circuits which are potentially lethal. Because of its size and weight, electrical and mechanical stability must be ensured. The following safety guidelines must be followed when operating or servicing this equipment. These guidelines are not a substitute for vigilance and common sense. California Instruments assumes no liability for the customer's failure to comply with these requirements.

APPLYING POWER AND GROUNDING

Verify the correct voltage is applied to the unit (100 to 240 VAC Nominal). Verify that the input power cord is plugged into a properly grounded utility outlet.

FUSES

Use only fuses of the specified current, voltage, and protection speed.
Do not short out the fuse holder or use a repaired fuse.
The 801RP/1251RP unit uses a North American ferrule type fuse rated at 15A and 250Volts. (Fast Acting)

DO NOT OPERATE IN A VOLATILE ATMOSPHERE

Do not operate the power source in the presence of flammable gases or fumes. This product is designed to operate in a controlled environment. Do no expose to rain or snow.

DO NOT TOUCH ENERGIZED CIRCUITS

Disconnect the power cable before servicing this equipment. Even with the power cable disconnected, high voltage can still exist on some circuits. Discharge these voltages before servicing. Only qualified service personnel may remove covers, replace components or make adjustments.

DO NOT SERVICE ALONE

Do not remove covers, replace components, or make adjustments unless another person, who can administer first aid, is present.

DO NOT EXCEED INPUT RATINGS

Do not exceed the rated input voltage or frequency. Additional hazards may be introduced because of component failure or improper operation.

DO NOT MODIFY INSTRUMENT OR SUBSTITUTE PARTS

Do not modify this instrument or substitute parts. Additional hazards may be introduced because of component failure or improper operation.

MOVING THE POWER SOURCE

When moving the power source, observe the following:

1. Remove all AC power to unit.

2. Use two people to prevent injury.

SURFACE STABILITY

1. Operate the power source only on a level surface.

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, 9689 Towne Centre Drive, San Diego, CA 92121-1964. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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1. Introduction

This instruction manual contains information on the installation, operation, calibration and maintenance of the RP Series AC power source.

1.1. General Description

The 801RP/1251RP AC source is a high efficiency, light weight 800VA or 1250VA programmable AC power source. The output has two voltage ranges of 0-135V or 0-270V with a frequency range of 16 Hz to 500 Hz. The maximum output current for the 1251RP is 9.2 amps on 135 volts range and 4.6 amps on 270 volts range.

The maximum output current for the 801RP is 6 amps on 135 volt range and 3 amps on 270 volts range.

The universal nominal input can be from 100 volts to 240 volts at 50 Hz or 60 Hz line frequency.

Simple front panel controls enable the voltage, current limit and frequency to be changed. An optional RS232C and IEEE 488 interface is available for applications that require remote control and measurements.

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2. Specifications

All specifications at 25 ±5°C unless noted otherwise.

2.1. Electrical

2.1.1. Input

Line Voltage:	85V to 264V maximum.
	100V to 240V nominal.
Line Current:	15 A RMS max.
Line Frequency:	47-63 Hertz.
Efficiency:	80% (typical) depending on line and load.
Power Factor:	0.95 or greater typical.
Inrush Current:	70 A peak max. at 260V input.
Hold-Up Time:	20 ms (with no effect on output).
Isolation Voltage:	Input to output = 2200 VAC, input to chassis = 1350 VAC.

2.1.2. Output

Voltage Range:	0 to 135 V rms or 270 V rms
Voltage Resolution:	0.1 volt
Voltage Accuracy:	±1% of range, 50 to 60 Hz.
	±2% at 400 Hz
Line & Load Regulation:	1% of FS on low range, 0.5% of FS on high range.
Voltage Distortion:	0.5% typical. THD at 50/60 Hz.
Total Power:	800 VA maximum at full scale voltage, either range (Model 801RP).
	1250 VA maximum at full scale voltage either range (Model 1251RP).

Note: On the 1251RP, the maximum output power is limited to 1000VA when the input voltage is below 120VAC.

⚠ Current: 6.0 A rms, 18 A peak (low range, Model 801RP)

3.0 A rms, 9 A peak (high range, Model 801RP)

9.2 A rms, 27.6 A peak (low range, Model 1251RP)

4.6 A rms, 13.8 A peak (high range, Model 1251RP)

Current Limit:		801RP	1251RP
135V range:	0.0 to	6.0	9.2
270V range:	0.0 to	3.0	4.6

Accuracy: Programmed value +5% of maximum current

Frequency Range:	Range	Resolution
	16.0 - 99.9 Hz	0.1 Hz
	100 - 500 Hz	1 Hz

Frequency Accuracy: ±0.02% of programmed value.

DC Offset Voltage: Less than ±25 mV with linear load.

Output Noise: <0.2 volts RMS on 135 range, <0.5 volts RMS on 270 range.

2.1.3. Measurements

Current (TRMS)

Resolution: 0.1 amp

Accuracy: ± 0.2 amp

Voltage Accessible only through RS232/ IEEE 488 Interface

	0 - 250V	251 to 270V
Resolution	1 Volts	2 volts
Accuracy:	±4 Volts	±6 volts

2.1.4. System Specification

Non Volatile Memory Storage:	8 complete instrument setups [Accessible through RS232C interface only].	
RS232C Interface:	Bi-directional serial interface	
[optional]	9 pin D-shell connector	
	Handshake:	CTS, RTS
	Data bits:	8
	Stopbits:	1
	Parity:	None
	Baud rate:	9600
	IEEE 488.2 commands and SCPI	
IEEE Interface:	Bi-directional parallel interface	
	24 pin D-shell connection	
	IEEE address:	set using dip switch on rear panel from 0 to 31
	IEEE functions:	SH1, AH1, T8, L3, RL2
	Terminators:	LF, CRLF, EOI
	IEEE 488.2 commands and SCPI	
Remote Inhibit	(Option –RI required)	
	Rear panel connector:	BNC
	Input	Contact closure to ground or logic low TTL signal required to turn off output. Automatic recovery when RI signal is removed.

2.1.5. Unit protection

Input Overcurrent:	Electronic current limit with fuse.
Input Overvoltage Transients:	Surge protection to withstand EN50082-1 (IEC 801-4, 5) levels.
Output Overcurrent:	Shutdown, 0.1 second after overcurrent.
Output Overvoltage:	Shutdown, recycle input power to reset.
Output Short Circuit:	Peak current limit. Shutdown after 0.1 seconds.
Overtemperature:	Automatic shutdown.

2.2. Mechanical

Dimensions:	16.51"(419.4mm) width x 3.5"(88.9 mm) height x 22"(558.8mm) depth chassis size stand-alone configuration.
Unit Weight:	37 lbs.
Material:	Aluminum chassis, panels and cover.
Finish:	Yellow iridite then painted semi-gloss polyurethane
Cooling:	Fan cooled with air intake on the sides and exhaust to the rear.
Internal Construction:	Modular sub assemblies.
Chassis Slides:	General Devices C300S-118-B308 (use hardware provided to prevent damage to unit)

Front Panel Mounted Output Connections:

CEE 7/7	European socket
US domestic	Single 5-15R 120V line socket

Rear Panel Mounted Connections:

RS232C	Interface	DB 9
IEEE-488	Interface	D-shell 24 pin
Output		Phoenix Contact HDFK4
Line Input		IEC 320

2.3. Environmental

Operating Temp:	0 degrees to +40 degrees Celsius.
Storage Temp:	0 degrees to +70 degrees Celsius.
Humidity:	Operating: ≤90% RH up to 40° C. Storage: ≤90% RH up to 40° C, ≤75% RH up to 70° C.
Creepage and Clearance:	Rated for Pollution Degree 2.
Insulation:	Rated to Installation Category (Overvoltage Category) II
Vibration:	Designed to meet NSTA 1A transportation levels.
Shock:	Designed to meet NSTA 1A transportation levels.

2.4. Regulatory

Electromagnetic Emissions and Immunity:	Designed to meet EN50081-1 and EN50082-1 European Emissions and Immunity standards as required for the "CE" mark.
Acoustic Noise:	65 dBA maximum at 0% to 50% load, 75 dBA maximum greater than 50% load to 100% load. Measured at one meter.
Safety:	Designed to meet UL3111 and EN61010-1 European safety standards as required for the "CE" mark.

2.5. Front panel controls

Controls:	Shuttle knobs: Allows continuous change of Voltage, Frequency and Current limit. Function keys: Controls Output state, Voltage range and Display mode.
Displays:	Two, 4 digits, 0.5" LCD display. For viewing programmed voltage, frequency, current limit and for displaying measured current.
Status Indicators:	6 LEDs to indicate: REMOTE, FAULT, OUTPUT (ON/OFF), VOLTAGE RANGE, FREQUENCY or CURRENT DISPLAY MODE (Refer to paragraph 4.1.2).

2.6. Available Options

The following options are available on 801RP and 1251RP AC power source models.

Option	Description
-IF	Combined IEEE-488 / RS232C interface option.
-L22	Locking knobs. Prevents front panel change of voltage and frequency.
-RI	Remote Inhibit rear panel input.
-RMS	Rack mount slides P/N 210367 General Devices Model C300S-118-B308

3. Unpacking and Installation

3.1. Unpacking

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. ***DO NOT*** return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

3.2. Power Requirements

The AC Power System has been designed to operate from a single phase AC line voltage. The nominal operating voltage is from 100V to 240V line input.

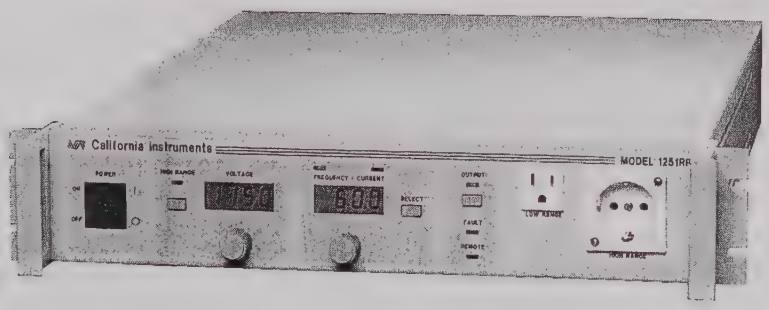


Figure 3-1: The 801RP/1251RP AC Power Source

WARNING: Do not connect the unit to a 400-480 service as the result will be a severely damaged unit.

3.3. Mechanical Installation

The AC Source is a completely self contained power unit. It can be used free standing on a bench. The unit is fan cooled, drawing air in from the sides and exhausting at the rear. The sides of the unit must be kept clear of obstruction and a 4 inch clearance must be maintained to the rear.

3.4. Input Wiring

The AC Source is designed to work from a single utility supply. The IEC 320 input connector will accept a standard IEC line cord with the appropriate mating connector for the utility outlet. The utility outlet must be properly grounded and be capable of supplying at least 1725 VA at 120V to 240V in order to deliver full output power in the 1251RP.

Note: When using less than 120 V line input, the 1251RP should be used at no more than 1000 VA output power to limit the input line current to less than 15A.

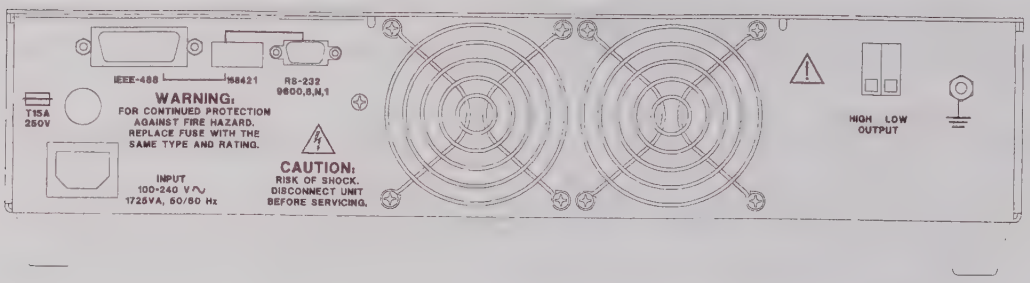


Figure 3-2: Rear Panel View

3.5. Output Connections

3.5.1. Output wiring

Front Panel

When the low voltage range is selected, only the single US NEMA 5-15R output socket will be active. If the high voltage range is selected, only the European CEE7/7 socket will be active.

Either voltage will be present on the output terminals at the rear panel. There is only one output terminal on the rear panel marked HIGH and LOW. This output carries the output of the AC Source in both high and low voltage range. The HIGH and LOW label on the rear panel refer to output high side and output low side (return) respectively, not to the voltage range selected.

Note: Do not connect these outputs together as this will cause the unit to fault.

3.6. Output Voltage Ranges

The AC power source has two standard output voltage ranges 0-135V and 0-270V. The operator may switch from one range to the other at will with no special precautions except to remember that the output voltage will go to zero voltage whenever a range change takes place.

Note: The output changes to the other socket on front panel with a range change.

3.7. Functional Test

CAUTION: Work carefully when performing these tests - hazardous voltages are present on the input and output during this test.

Refer to Figure 3-3 for the test set up.

1. Connect an oscilloscope, voltmeter and/or distortion analyzer to the AC source output at the 135 Volt output terminal.

2. Connect the AC power input voltage connections to the AC source input terminals. Turn on the power switch located at the rear panel.

3. Verify that the front panel LCD display reads out the initial start up voltage and frequency.

4. Select the low voltage range. Set the frequency to 60 Hz with the right shuttle. Select the current function with the Frequency/Current selector. Set the current limit to the maximum value using the right shuttle. Set the output voltage to 135V with the left shuttle.

5. Enable the output by pressing the output "on/off" button in the top right of the front panel. The green LED above the button will illuminate when the output is on. The output should be a clean 135 volt AC sinewave having less than 1% distortion.

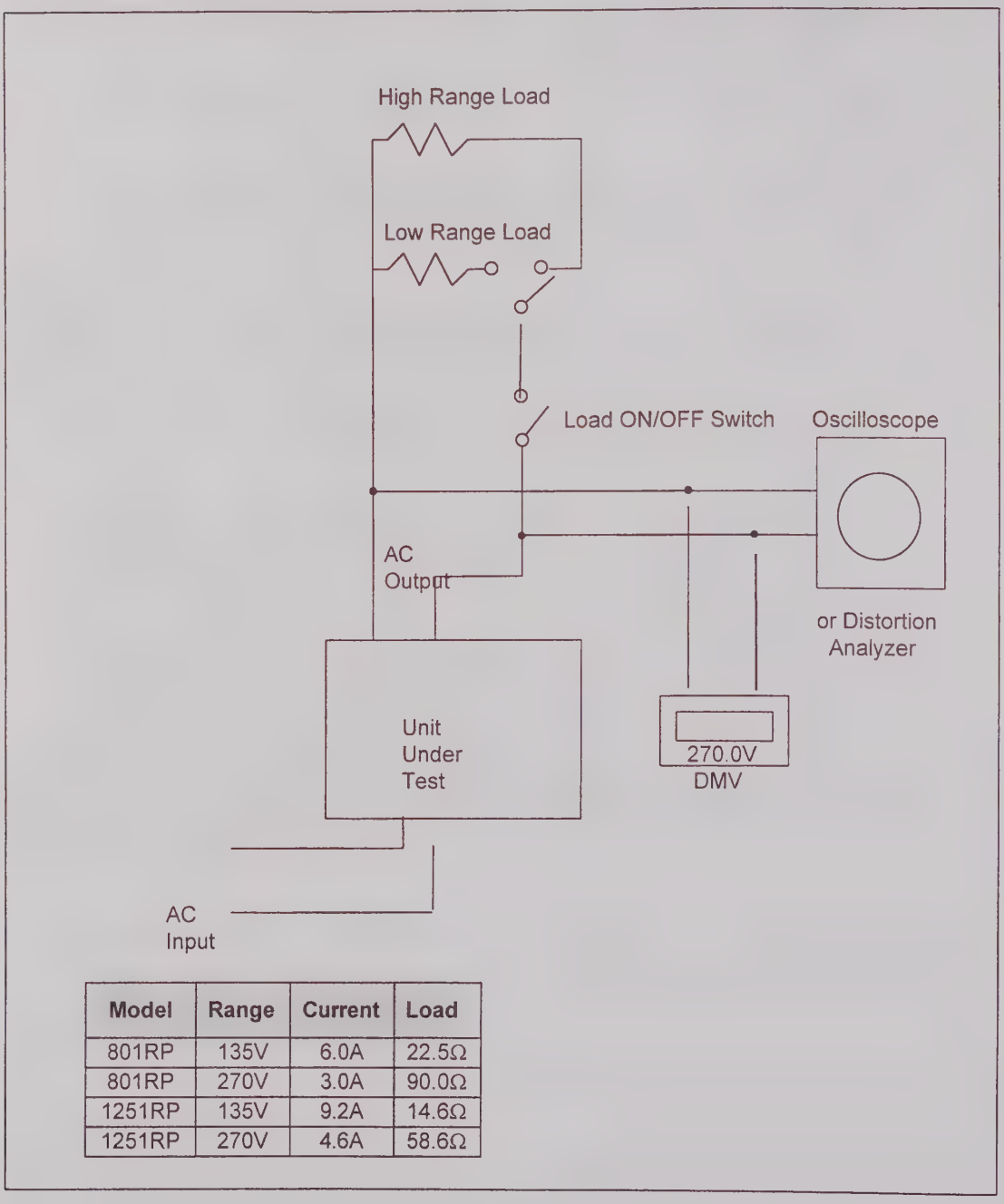
6. Apply full load (refer to table on Figure 3-3) to the output of the source and verify the output remains within 2% of the initial 135 volt value. The output should still be clean and the distortion should still be less than 1% at 60 Hz.

7. Using the right shuttle set the output current limit value to 6 amps. The system should go into current limit and give an error message on the display (err. -300) that indicates an output fault condition and the output will go off. Return the current value to the maximum current and disconnect the load.

8. Repeat steps 4 through 7 but set the output for the following: Hi voltage range and the current limit to maximum value. The output load should be connected to the Hi range output connector. The load value is shown in Figure 3-3, for the 270 volt output.

Note: Output connectors must be changed when changing voltage ranges unless the rear panel output terminals are used.

In the event the power source does not pass the functional test, refer to the calibration procedure in Section 6 or call California Instrument's customer satisfaction department for further assistance.



Model	Range	Current	Load
801RP	135V	6.0A	22.5Ω
801RP	270V	3.0A	90.0Ω
1251RP	135V	9.2A	14.6Ω
1251RP	270V	4.6A	58.6Ω

Figure 3-3: Functional test setup

4. Front Panel Operation

4.1. Front Panel Guided Tour

The front panel can be divided in a small number of functional areas:

- Output Sockets
- Status Indicator lights
- Shuttle knobs
- LCD display
- Button controls

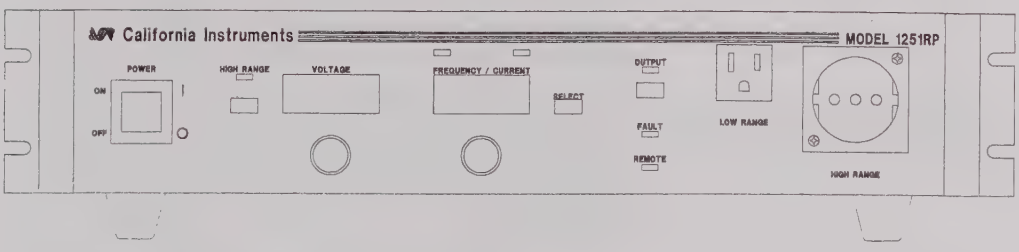


Figure 4-1: Front panel view

4.1.1. Output outlets

The Output Sockets are located on the right side of the front panel. It provides connection to the load from the AC source. When the low voltage range is selected, only the US NEMA 5-15P output socket will be active. If the high voltage range is selected, only the European CEE7/7 socket will be active. Refer to Figure 3-1 and Figure 4-1 for socket locations. Both voltage ranges are present at the rear panel output terminals however. Refer to Figure 3-2.

4.1.2. Status Indicator lights

Six LED status indicators are located directly above the LCD display. These LED's correspond to the following conditions:

REMOTE	The REMOTE LED indicates that the unit is in remote control mode. If the RS232C interface is used, the REMOTE state can be enabled by the controller using the SYST:REM command. Any time the REMOTE LED is lit, the front panel of the RP Series unit is disabled. There is no LOCAL button that allows the user to regain control of the front panel. The SYST:LOC command will enable the front panel controls. When using IEEE, the remote /local state is controlled by the REN (Remote Enable) interface line.
FAULT	The FAULT LED indicates an output overvoltage or overtemperature condition. Overtemperature is usually caused by poor air flow. Check the air flow exhaust at the rear of the unit to make sure it is not obstructed.
OUTPUT	The Output LED indicates the status of the OUTPUT ON/OFF button. When the Output LED is not lit, the output voltage is not present at the output socket regardless of the voltage setting.
RANGE	The Range LED indicates the selected output voltage range. When it is illuminated it indicates the high voltage range has been programmed.
FREQUENCY	Illuminates when the LCD display shows the programmed frequency.
CURRENT	Illuminates when the LCD displays shows the programmed current limit or measured current values.

4.1.3. The Shuttle knobs

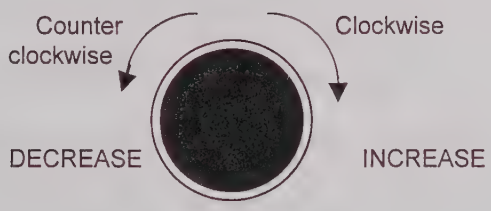


Figure 4-2: Shuttle Knob

There are two shuttle knobs located below the LCD display which are used to change setup parameters for voltage, frequency and current limit. The mode button selects the function of the right shuttle. The right shuttle will control either the frequency or the current limit as indicated by the indicator above the right LCD.

4.1.4. FUNCTION Buttons

There are three function buttons for the Output Voltage Range, Output State and Shuttle Mode. The following is a description of these buttons:

KEY	DESCRIPTION
RANGE	The RANGE button is used to change the voltage range between the low range (0 to 135 volts) and high range (0 to 270 volts). The LED above the switch will light to indicate the high voltage range selection. The output voltage will be reset to zero voltage after a range change.
OUTPUT	The OUTPUT button will toggle the output to enable or disable the output. The LED above the button will light when the output is on. No output voltage will be present when the OUTPUT button is off despite the level of voltage programmed.

MODE

The MODE button selects the function of the right Shuttle knob and the LCD display. The Shuttle will control the output frequency and the display will show the program frequency value when the mode selection is frequency. The Shuttle knob will program the current limit and the display will show its value in the current mode. The display will revert back to showing the measured current after 3 seconds from the last movement of the shuttle. The measurement is updated 4 times per second. The display mode is indicated by the two LED's above the LCD display.

4.1.5. LCD Display

The LCD display consists of two 4 digit, 7 segment displays. The voltage display shows the programmed voltage. The Frequency/Current display shows either the programmed frequency or current limit. In the current limit mode the display switches to display the output current after 3 seconds. The Frequency/Current select button will define the operating mode of the frequency/current display.

4.2. How to...

This chapter covers some common tasks that are often performed with an AC power source. These examples are written in a How to... format and provide step by step instructions on how to set up the AC Source for a specific task.

4.2.1. Set the output

Output parameters are Voltage, Frequency and Current Limit.

1. Disable the output by pressing the OUTPUT button. The LED above the button will turn off.

2. Use the left shuttle to set the output voltage. Clockwise will increase the output, counter clockwise will reduce the output. The display above the shuttle will show the voltage setting.

3. Use the right shuttle to set the frequency and current limit. The Frequency/Current select button will define the function of the shuttle and the display above it. The Frequency or Current LED will turn on to indicate the function controlled by the right shuttle.

4. Enable the output by pressing the OUTPUT button.

4.2.2. Slewing output values

The output parameters can be slewed using the shuttles.

1. Enable the output by pressing the OUTPUT button. The LED above it will turn on.

2. Use the left shuttle to set the output voltage. Clockwise will increase the output, counter clockwise will reduce the output. The display above the shuttle will show the voltage setting.

3. Use the right shuttle to set the frequency and current limit. The Frequency/Current button will define the function of the shuttle as indicated by the display above it. The Frequency or Current LED will turn on to indicate the function in control.

4.2.3. View current measurements

Current measurements can be called up as follows:

1. Press the Frequency/Current button to select the Current function.

2. Immediately the Frequency/Current display will show the measured current.

3. Moving the right shuttle will interrupt the current measurement. The display will show the current limit value.

4. After a short delay the display will revert back to show the measured current.

4.2.4. Voltage range change

The voltage range can be changed as follows:

1. Press the HI RANGE button located in the upper left corner. The output voltage will reset to 0 volts.

2. Use the left shuttle knob to set the output voltage.

4.2.5. Output Control

The Output can be disabled or enabled as follows:

1. Pressing the OUTPUT button when the output LED is on will disable the AC source output. The programmed voltage setting will remain at the last program value.

2. Pressing the OUTPUT button again will enable the output voltage and the output will revert to the last programmed value.

4.2.6. Setting the Power on Initialization Values

All P and RP series are supplied with default factory settings when the unit is powered up. The factory settings are:

Voltage range Low

Voltage	0 V
Frequency	60 Hz
Current limit	Max available current
Display mode	Frequency
Output	OFF

It is possible to change the power on initialization values in one of two ways:

1. Using the optional RS232 or IEEE-488 (RP only) interface and the supplied PGUI/PGUI32 program.

2. Using the front panel. (requires main firmware release 1.0 or higher).

To change the power on initialization values from the front panel, proceed as follows:

1. Set the unit up in the desired way from the front. (Range, voltage, frequency, current limit, output relay state). Note: The display mode – frequency or current – is not saved as part of the set up and always defaults to frequency.

2. Press and hold the Select key (normally toggles between F and C readouts).

3. While holding the Select key, press the OUTPUT ON/OFF key. This will save the present front panel settings in non volatile memory register (NVM) no 7 and assign this register as the power on register.

4. Release both keys.

5. This procedure can be repeated as often as needed by the user.

5. Principle of Operation

5.1. General

An explanation of the circuits in the AC Source is given in this section. Refer to Figure 5-1 for a block diagram of the system.

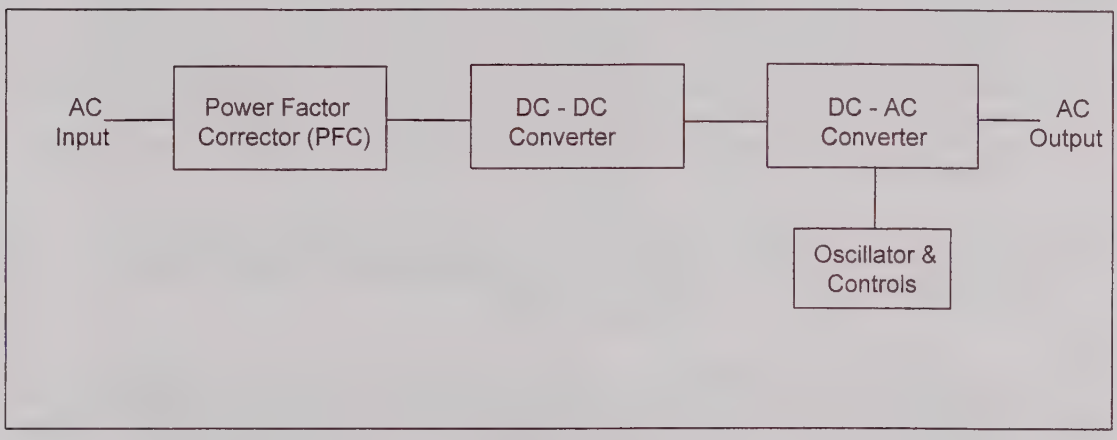


Figure 5-1: AC Source block diagram

5.2. Overall Description

The AC input is fed to the power factor correction, boost type converter. The converter steps the voltage to 385 VDC while drawing near sinusoidal current from the input power line.

The DC to DC converter provides isolation and changes the voltage to 250 VDC or 400 VDC depending on whether the low output range or high output range is selected.

The DC to AC converter develops an AC sine wave voltage at the output frequency and amplitude programmed by the oscillator.

The oscillator board provides the reference signal to the DC to AC converter and has the front panel shuttles and switches to control and view the setting of voltage, frequency and current limit.

5.3. Power Factor Correction Module (PFC)

The PFC consists of the boost converter circuitry. The boost converter is PWM controlled by a single chip that adjusts the pulse width during the cycle so that near sine wave current is drawn from the supply. An auxiliary winding on the boost inductor provides "bootstrap" power to the logic circuits and is self sustaining.

5.4. DC - DC Converter Module

The 385 VDC from the PFC is fed to the DC to DC module. It first supplies 385 volts DC to the auxiliary power supply. When the auxiliary power supply starts, it supplies six isolated DC supplies to the AC module. It also supplies 15 volts to the DC converter on the same DC module. The DC to DC converter will then start operating. The DC converter supplies either 250 volts DC or 400 volts DC to the DC to AC module.

The DC to DC converter is a full bridge converter and the auxiliary converter is a two FET forward converter.

All the eight LEDs on the DC-DC board should be lit under normal operation. The LED DS200 is lit when the DC output is up and within regulation. The amber LEDs DS5, DS4 and DS3 indicate that the 15V power to the optocouplers on the AC converters is within regulation. The red and green LED's, DS7 and DS6 indicate logic power to the AC converter is ok. The red LED DS8 indicates that logic power to the DC converter is within specification at 15 volts. The LED DS2 shows that 24 volt fan power is available.

Table 1: Logic Board Led's

LED#	FUNCTION	COMMENTS
DS2	24V ok	24 volt fan power is available.
DS3	15V ok	15V power to the optocouplers on the AC converters is within regulation
DS4	15V ok	15V power to the optocouplers on the AC converters is within regulation
DS5	15V ok	15V power to the optocouplers on the AC converters is within regulation
DS6	power ok	logic power is ok to the AC converter
DS7	power ok	logic power is ok to the AC converter
DS8	power ok	logic power is ok to the DC converter
DS200	DC bus ok	DC output is up and within regulation

5.5. Oscillator Control Board

The Oscillator control board has the Microcontroller and all the control logic to generate a programmable sine wave reference of the correct amplitude and frequency. It includes all the control logic to respond to user commands from the front panel or the remote control interface. It also updates the displays to show the programmed settings and current measurements. Refer to Figure 5-2 for a block diagram.

When the output is programmed above 5.0 volts, the multicolor LEDs, DS10 and DS9, on the oscillator board will illuminate.

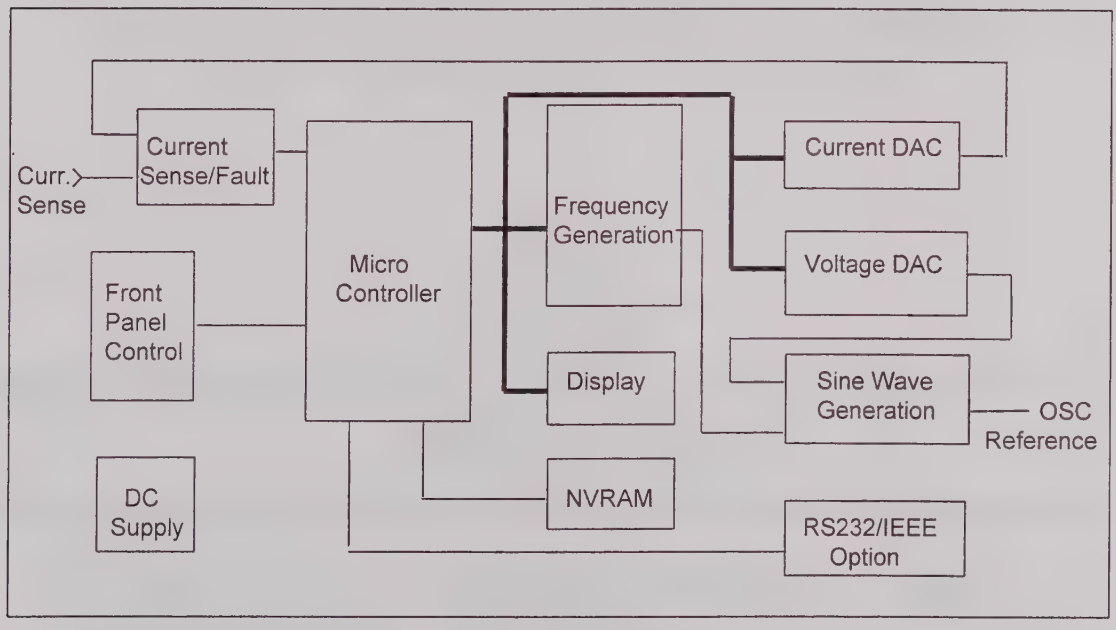


Figure 5-2: Oscillator and controls

5.6. DC to AC Power Module

The DC to AC power Module takes a 250V DC input and generates 0 to 135 volts AC, directly coupled, low range output. When the DC to AC module is supplied with 400 volts DC, the AC module generates 0 to 270 volts AC. The output converter is a PWM full bridge topology with an LC filter on the output. The switching frequency is 34.6 kHz.

This module has pulse by pulse peak current limit and sinusoidal average current limiting to protect the power transistor and load.

5.7. IEEE 488/ RS232

The RP can optionally be outfitted with a combined RS232C and IEEE 488 interface board. This board assembly has optocouplers for interface isolation.

The interface in use is selected by a DIP switch on the rear panel. Only one interface can be active at any given time.

CAUTION

VOLTAGES UP TO 270 VAC AND 400 VDC ARE PRESENT IN CERTAIN SECTIONS OF THIS POWER SOURCE. THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES.

DEATH

ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.

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6. Calibration

Routine calibration should be performed every 12 months. Non-routine calibration is only required if a related assembly is replaced or if the periodic calibration is unsuccessful.

The calibration involves removing the top cover from the power source. Remove the line power from the power source before removing the top cover. Some of the adjustments are on the Oscillator Assembly A4. Other adjustment are on the DC-AC Board Assembly. Refer to Figure 6-3 for the location of the adjustments.

6.1. Calibration Equipment

Digital Multimeter:	Fluke 8840 or HP 34401A
100 milliohm Current Shunt:	Isotek Model RUG-Z-R100-0.1 or equivalent
Load Bank:	Various power load resistors will be needed

Table 2: Load and current

Model	Range	Current max	Load
801RP	135V	6.0A	22.5Ω
801RP	270V	3.0A	90.0Ω
1251RP	135V	9.2A	14.6Ω
1251RP	270V	4.6A	58.6Ω

6.2. Routine Calibration

Setup:
Connect the test equipment to the power source as shown in Figure 6-1. Refer to Figure 6-3 for adjustment locations.

The DMM can be connected to the front panel connectors for convenience but will have to be changed when switching voltage ranges. To avoid this, use the common output terminal at the rear of the unit.

For best results use the output connectors (Front or Rear) that are typically used.

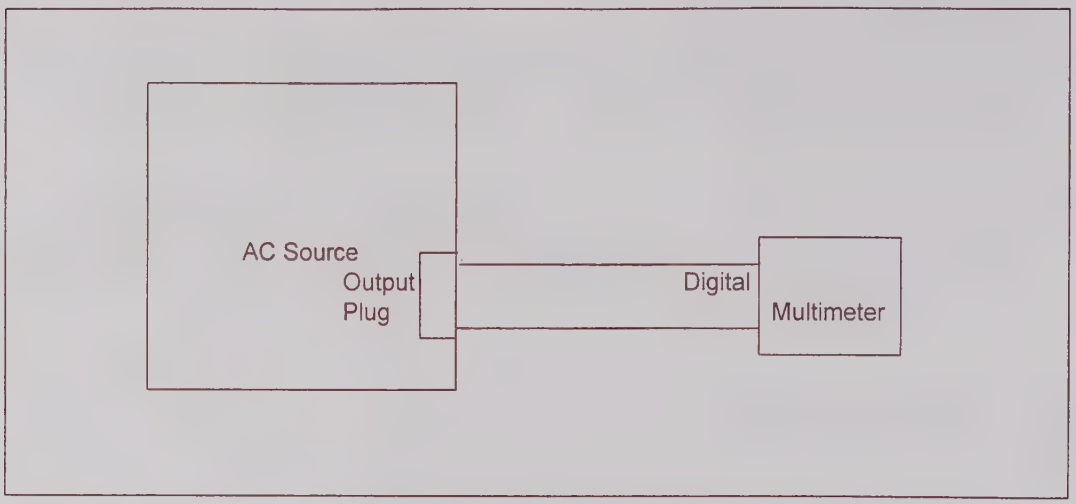

Figure 6-1: Test Equipment Hookup for Routine Output Calibration

6.2.1. Output Voltage Calibration

1. Select the low voltage range. Set the output frequency to 60Hz. Set the output voltage to 135 volts.

2. Remove the load and enable the output voltage with the Output ON/OFF button.

3. Locate R111 on A3 assembly board and adjust R111 so that the external voltmeter will read 135.0V ±0.1V.

6.2.2. Current Measurement Calibration

1. Connect the test equipment to the power source as shown in Figure 6-2.
2. Connect the load to the output. Use the 100 milliohm current shunt in series with the load to measure the AC load current. Refer to Table 2 for the proper full load.
3. Read the output voltage across the shunt with the external voltmeter.
4. To calibrate the current measurement functions, select the current function with the frequency/current button. The current measurement readout will appear on the display.
5. Locate R29 on assembly board A4. Adjust R29 so that the current reading agrees with the current measured with the external shunt and voltmeter.

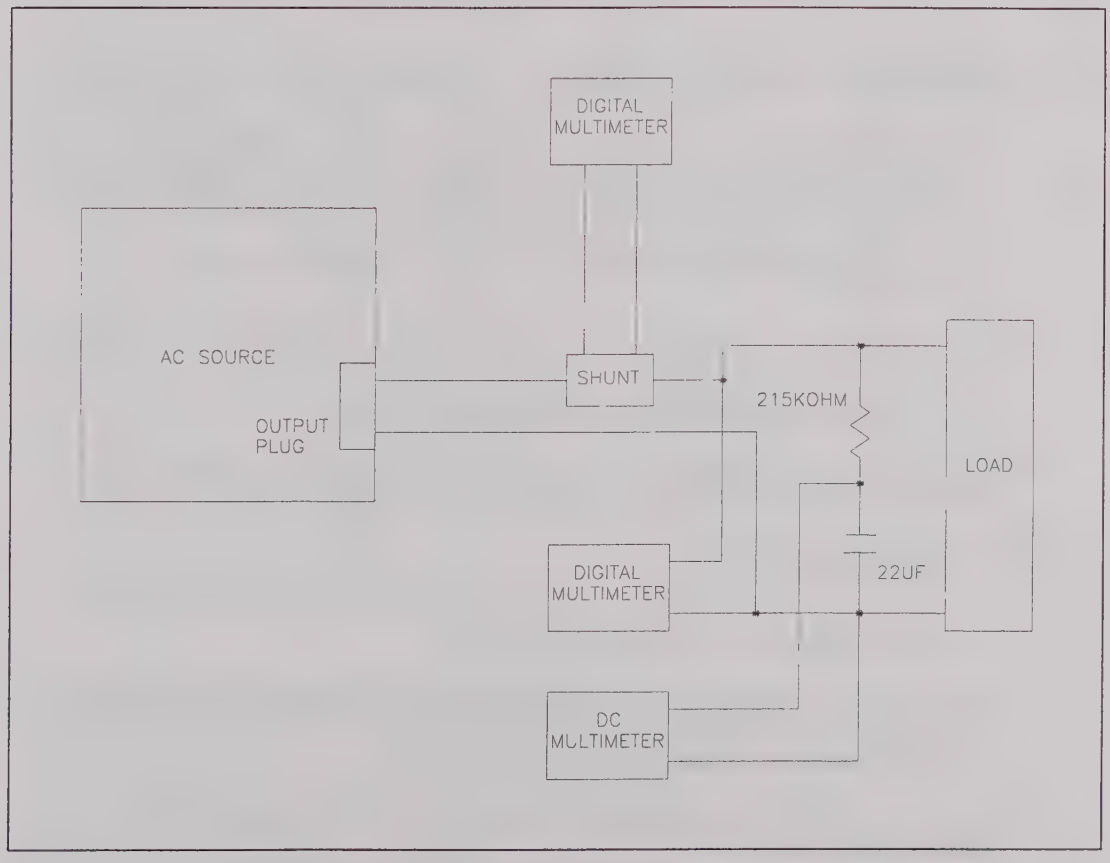

Figure 6-2: Test Equipment Hook-up for Measurement Calibration

6.3. Non-Routine Calibration

6.3.1. Current Limit Calibration

1. Connect the test equipment to the power source as shown in Figure 6-2.
2. Locate R31 on the A4 assembly board. Turn R31 clockwise several turns.
3. Connect the load to the output. Use the 100 milliohm current shunt in series with the load to measure the AC load current. Refer to Table 2 for the proper full load.
4. Set the Current limit with the right shuttle to 95% of the current measured with the shunt and AC Multimeter.
5. Turn R31 counterclockwise slowly until the output faults.

6.3.2. Voltage Measurement Calibration

1. This calibration requires the use of P/RP GUI and a PC communicating with the AC source via the RS232 interface. The IEEE interface can be used as well, but requires that the PC is equipped with a National Instrument GPIB controller card.
2. Refer to Section 9 for Installing and starting the GUI to monitor the voltage measurements.
3. Program the output voltage to 170 volts and 200 Hz. The output must not be loaded.
4. Monitor the output voltage with an external voltmeter.
5. Locate R128 on the A3 assembly board. Adjust R128 so that the measured value reported by the GUI measurements agrees with the external voltmeter.

6.3.3. DC Offset Adjustments

1. Program the output voltage to 230 volts and 60 Hz.
2. Measure the DC offset at the output using a Fluke 8840 or equivalent. Verify that offset is less than ± 0.025V. Measure the DC voltage across a 22 μf capacitor connected to the output through a 215K resistor. Refer to Figure 6-2.
3. Locate R46 on the A3 assembly board. Adjust R46 if required to maintain the DC offset within 0 ±0.025 VDC.

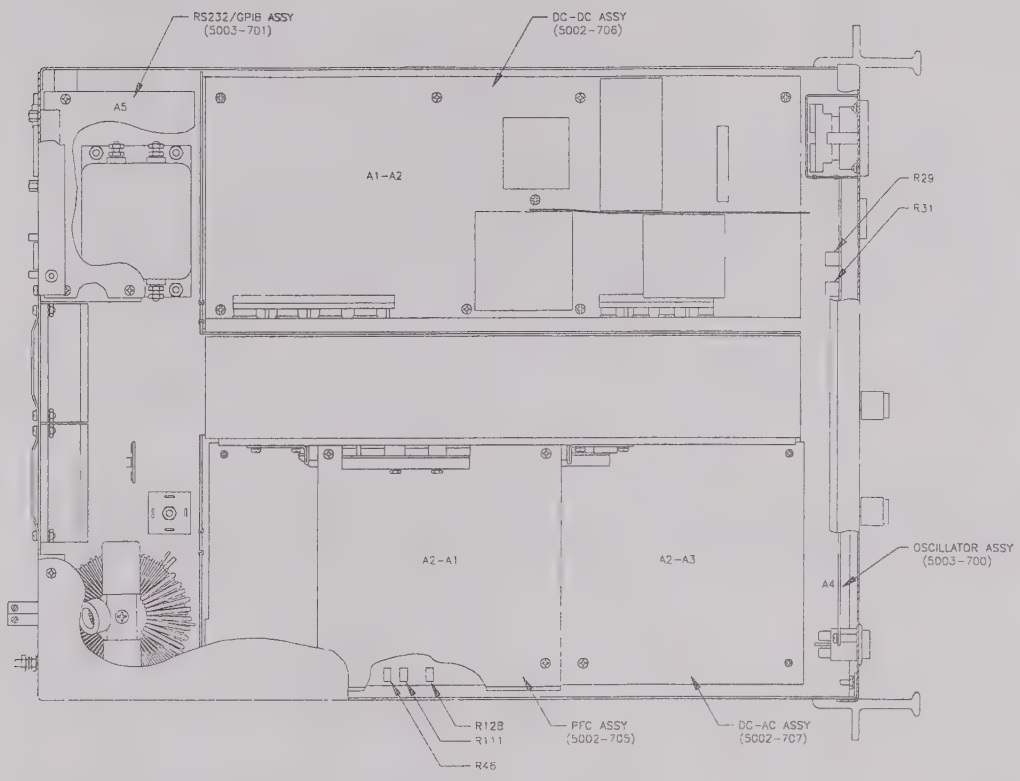

Figure 6-3: Location of Internal Adjustments

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7. Service

7.1. General

This section describes the suggested maintenance and troubleshooting procedure. The troubleshooting procedure is divided into two sections. The first section deals with basic operation and connection of the equipment. The second section requires opening the unit and using the LED indicators and a simple multimeter to troubleshoot the unit down to the module level. Only a qualified electronic technician should attempt this level of troubleshooting.

7.2. Basic Operation

Table 3: Basic Symptoms

PARAGRAPH	PROBLEM
7.2.1	Poor Output Voltage Regulation
7.2.2	Overload Light On
7.2.3	Distorted Output
7.2.4	Unit Shuts Down After 3-5 Seconds
7.2.5	No Output and no lights on front panel
7.2.6	No output but "power on" LED on front panel is lit.

7.2.1. Poor output voltage regulation

Table 4: Poor output voltage regulation

CAUSE	SOLUTION
Unit is overloaded	Remove overload
Unit is programmed to wrong voltage range.	Select correct voltage range.
Input line has fallen below spec. limit.	Check supply voltage.

7.2.2. Overload light is on

Table 5: Overload Light On

CAUSE	SOLUTION
Unit is overloaded	Remove overload
Unit is switched to high voltage range.	Select correct voltage range.

7.2.3. Distorted output

Table 6: Distorted Output

CAUSE	SOLUTION
Power source is grossly overloaded.	Reduce load
The crest factor of the load exceeds 3:1	Reduce load current peaks by reducing load.

7.2.4. Unit shuts down after 3-5 seconds

Table 7: Unit shuts down after 3-5 seconds

CAUSE	SOLUTION
Output shorted	Remove output short
Output grossly overloaded.	Remove overload.
Operating load with too high inrush or start up currents.	Consult factory for application advice.

7.2.5. No output and no lights on front panel

Table 8: No output and no lights on front panel

CAUSE	SOLUTION
Rear panel power switched off.	Switch the breaker on.
No input power to the input connector	Ensure correct input power
Blown fuse.	Check fuse in the rear panel and replace with same type and rating.

7.2.6. No output but "power on" led on front panel is lit

Table 9: No output but "power on" led is lit

CAUSE	SOLUTION
"OUTPUT ON" switch is turned off.	Turn OUTPUT ON switch to "ON".
Power cord plugged into the wrong socket	Only USA socket is energized when low range is selected.
Current limit programmed down or to zero.	Program current limit higher.
Voltage programmed down or to zero.	Turn amplitude control up.
Fault LED is lit	Cycle Rear Panel power switch off and on.

7.3. Advanced Troubleshooting

WARNING: DO NOT CONNECT 400-480V TO THE UNIT, THE RESULT WILL BE A SEVERELY DAMAGED UNIT.

CAUTION: VOLTAGES UP TO 270 VAC AND 400VDC ARE PRESENT IN CERTAIN SECTIONS OF THIS POWER SOURCE.

WARNING: THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.

7.3.1. Switch off unit

Switch off the unit with the power on/off switch on the rear panel as well as removing the input power from the unit.

WARNING: Wait 10 minutes for all internal capacitors to discharge.

7.3.2. Removing top cover

Remove the screws securing the top cover and remove the top cover.

7.3.3. Initial inspection

Perform a visual inspection of the unit and ensure all the connectors are properly mated and there are no loose or broken wires.

7.3.4. Connectors and Fuses check up

Ensure all connectors are properly mated and there are no broken wires. Check fuse F1 on the A2 assembly and fuse F2 on the A3 assembly. Replace with the same type fuse.

7.3.5. Power on troubleshooting using the LED'S

If no fuses were blown or if fuses were found blown but all the IGBT's checked out good and the fuses have been replaced, reconnect power to the unit.

WARNING: Do not touch any parts inside the unit during this test as they will be live and dangerous. Always wear safety glasses.

7.3.6. No Output, no front panel LEDs

Is LED on P.F.C. unit lit? OK if flickering with no load on output. If not lit, check input fuse and wiring on P.F.C. module. P.F.C. module is the one in the center. If LED is not lit and power is available at the EMI filter, replace P.F.C. module.

If LED is lit, proceed to DC-DC converter. The DC-DC converter is on the left hand side when looking at the front. Are LEDs lit on the DC to DC board?

YES

If LEDs on the DC-DC board are lit and front panel LEDs are not lit, the problem is probably in the large ribbon cable that runs between the DC-DC and the AC converter.

NO

Check fuses on the DC-DC converter board. There is a 3 AMP (F2) fuse and a 10 Amp (F1) fuse both located in the center of the PC board. You will have to remove the two screws at the bottom of the unit to remove the module in order to replace the fuses.

TURN OFF THE UNIT AND WAIT AT LEAST 10 MINUTES BEFORE REMOVING MODULE.

If fuses are blown and there are signs of burn marks on the components, do not replace fuses and power up. Replace DC-DC module.

7.3.7. No Output LEDs on front are lit

Plug unit in and switch on. Are all the LEDs lit on the DC-DC board? 3 amber LEDs (DS3, DS4, DS5) if one or more of these LEDs is not lit the trouble is on the DC-AC board. Unplug the cable to the DC-AC module (after safely removing power). If all the LEDs are lit after power up, replace the DC-AC module as it has a shorted gate drive and probably blown power transistors.

Red and green LEDs, DS6 and DS7, on the back of the board provide power to DC-AC and the oscillator board. If either of these are not lit, switch off power, remove large ribbon cable from DC-DC converter and power up again. If LEDs are lit, the problem is on the DC-AC or the oscillator board. If the LEDs remain off, replace the DC-DC board.

If LED, DS8, is not lit, no power will be available to run the DC converter drive logic. Replace DC-DC module.

LED, DS2 (red), indicates 24V fan power available.

LED DS200, will be lit if the DC converter is running. If DS200 is not lit check fuse F1 on the DC-DC board as in paragraph 7.3.4 above.

If all LEDs are lit and the LED output indicator is lit but no output, then suspect the relay on DC-AC board.

If all 8 LEDs are lit on the DC-DC converter then the problem is on the DC-AC module. Switch off, then check wiring from the DC-AC board output to the output sockets on the front panel. If this is OK check the fuse, F2, on the DC-AC module. Switch off. Remove two screws from the underside of the enclosure to gain access to the module and F2. If the fuse is blown and a check shows signs of damage or burning on the board, **DO NOT REPLACE FUSE.** Replace DC-AC module. If there are no signs of burning or damage on the DC-AC board or components, then it could be assumed that it is a random fuse failure and it would be OK to replace the fuse and try again.

WARNING: In most cases when a fuse blows it is caused by a failed power semiconductor and repeatedly replacing a fuse will only cause severe damage to that or other assemblies.

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8. Introduction to PGUI/PGUI32

8.1. About This Program

The California Instruments Graphical User Interface program - PGUI/PGUI32 - was developed as a companion product to the California Instrument's P and RP Series AC power sources. It's main purpose is to provide a soft front panel to the instrument when connected to a PC through the RS232C or IEEE-488 interface. Additional benefits are obtained from using the PC as a control interface. Some of these benefits include the ability to store measurement data to disk, interact with other programs, and produce a transient simulation.

The PGUI is a Windows program and as such requires a PC capable of running Windows 3.1™, Windows 3.11™, Windows 95/98™, or Windows NT™. For best performance a 80486 or Pentium based PC is recommended. 80386 and 80486SX based PC's will exhibit poor performance while generating transients due to their lack of speed.

This section of the manual provides information related to installation of this software only. Complete information on how to use the PGUI/PGUI32 can be found in the on-line help supplied with the program. Use the Help menu or press on any of the many Help keys located in all program windows for an explanation of the relevant screen or function.

As always, California Instruments appreciates your patronage and would welcome any comments and suggestions you might have regarding this software or any of its other products. Use the End-user feedback form located on page 46. The same form can be used to report software bugs should you encounter any.

8.2. About This Section of the Manual

Note that this section of the manual covers the installation of the PGUI/PGUI32 software only. Use the on line help for complete information. It is strongly recommended that you familiarize yourself with the operation of the actual AC power source as well. This is best done by studying the rest of this user manual.

8.3. Program Requirements

To successfully install and operate the PGUI/PGUI32 program, you will need the following equipment:

- California Instruments AC power source. Supported models are :
    - 1001P
    - 1251P
    - 801RP
    - 1251RP
- PC capable of running Windows 3.1™, Windows for Workgroups 3.11™, Windows 95/98™ or Windows NT™

- RS232C communications port
- RS232C serial cable (supplied with the AC power source.) See next section for RS232C cable wiring

  or

- National Instruments IEEE-488 Controller Card

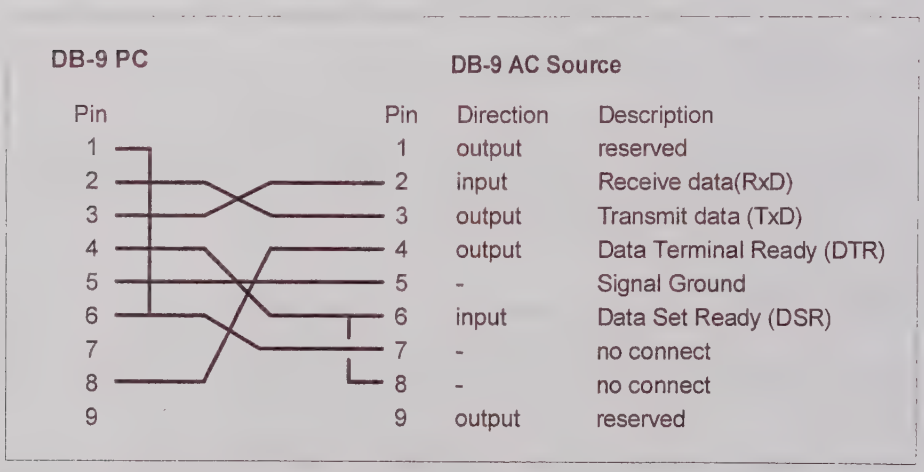
Note: The PGUI/PGUI32 can be run in the absence of a power source. If no AC source is available , the PGUI/PGUI32 can be operated in a simulation mode. The program will detect these conditions and start up in simulation mode after notifying the operator. Measurements in this case will be simulated and should not be used for any analytical purpose.

8.4. RS232C Cable Wiring

California Instruments AC power sources require a special RS232C cable to communicate with a PC. Standard null-modem cables obtained from a computer hardware store most likely will not work. For this reason, all California Instruments power sources that operate over RS232C are supplied with a RS232C 9 pin female to 9 pin female cable.

If for some reason this cable cannot be located, the following cable diagram shown in Figure 8-1 should be used when constructing a serial cable.

Figure 8-1: RS232C Cable Wiring



Note: This cable is not bi-directional so it is important to mark the PC side and the AC source side of this cable. If the cable is connected in reverse, it will not operate correctly.

9. PGUIPGUI32 Setup and Installation

This section covers installation of the PGUI from the distribution disk to the user's PC. Make sure the PC is capable of running Windows with at least 16 Mbyte of memory and 4 Mbyte of available hard disk space.

9.1. Connecting the AC Source to the PC When Using RS232

Connect the AC source to the PC using an RS232C cable.

The AC source com port settings are set as follows:

Baud rate: 9600 baud

Data bits: 8

Stop bits 1

Parity bits: none

Handshake: Hardware

The AC source is configured to accept the above setting.

Select the RS232 interface by sliding the interface selection dip switch on the rear panel to the RS232 position.

9.2. Connecting the AC Source to the PC Using IEEE-488

Connect the AC source to the PC using an IEEE-488 interface cable. A National Instruments GPIB controller card is required to use the PGUI program.

Select the IEEE-488 interface by sliding the interface selection dip switch on the rear panel to the IEEE-488 position.

Set the desired IEEE address using DIP switch position 4 through 0 on the rear panel.

9.3. Installing the PGUI Software

9.3.1. PGUI 16 Bit for Windows 3.1™

The PGUI software is distributed on a 3.5 inch high density diskette. The PGUI must be installed from this diskette as all required files are compressed. You cannot copy the contents of this disk to your PC hard drive and run it. To install the PGUI, proceed as follows:

1. Turn on the PC and boot up in Windows™.

2. Insert the PGUI disk in drive A or B. If you do not have a 3.5 inch drive on the PC, you can copy the contents of the disk to a 5.25 inch diskette on a PC that is equipped with both drive types.

3. From the Program Manager, select the "File" Menu.

4. From the File Menu, select "Run..."

5. At the prompt, type "A:SETUP" or "B:SETUP" depending on the drive designator of the drive in which you inserted the disk.

The setup program will first ask you for the destination directory on the hard disk where you want the PGUI installed. The default directory is "C:\PGUI".

6. Press "Continue" if you want to accept the default. If you want the program to reside at a different location, type in the complete path name including hard disk drive letter and then press "Continue". If you want to abort the setup procedure, click on the "Exit Setup" button. A warning will appear indicating the setup did not complete successfully. Click on the "OK" button to acknowledge the warning. This will take you back to the Program Manager.

7. Wait for the installation program to complete. An icon for the PGUI, the PGUI help file and a program group will be created automatically.

8. Remove the diskette from the drive.

You are now ready to start using the PGUI software.

9.3.2. PGUI32 32 Bit for Windows 95/98™ and Windows NT™

The PGUI32 software is distributed on two 3.5 inch high density floppy diskettes. The PGUI32 must be installed from these diskettes using the setup program located on disk 1 as all required files are compressed. You cannot copy the contents of these diskettes to your PC hard drive and run the program. To install the PGUI32, proceed as follows:

1. Turn on the PC and boot up in Windows™

2. Insert the first disk (labeled Disk 1 of 2) in drive A or B.

3. From the Windows Start Menu, select RUN.

4. At the "Open" prompt, type A:Setup or B:Setup depending on which disk drive you used and click on the OK button.

5. Follow the instructions provided by the setup program to complete the installation. At some point, you will be asked to insert the second disk (Disk 2 of 2). Remove the first disk and replace it with disk 2 and press Ok to continue the installation.

6. When the installation has completed, remove the second disk from the floppy drive and store both disks in a safe place.

Reboot the PC to activate the new settings. You are now ready to start using the PGUI32 software.

9.4. Trouble Shooting - RS232C

This section provides guidelines for resolving communication problems that may occur when using the PGUI /PGUI32 software under Windows 95/NT™.

You may encounter problems when using the serial interface with the PGUI program that is supplied with the interface option for this source.

Symptoms:

1. Unable to verify connection to the power source through RS232C interface. Timeout occurs and dialog box appears that asks if you want to switch to simulation mode. An error message (ERR -100) may appear on the front panel LCD's of the power source.

- Or -

2. Verification is successful but slewing of voltage, frequency or current limit results in an ERR -100.

Things to check first:

1. Is the PC com port you selected to use really available for this purpose? On older PC's com port interrupts are often shared between com 1 and com3 as well as com2 and com 4. If any of these other com ports is in use, it may prevent you from using the com port that shares the same interrupt.

2. Did you use the RS232C cable that was supplied with the P/RP AC source? This is not a null-modem cable and cannot easily be obtained at a computer store. If you do not have the original cable, consult the PGUI on line help under Interface settings for a wiring diagram.

3. Did you connect the cable in the right direction? This cable is uni-directional and should be marked with a SOURCE and a PC label. Make sure you connect the SOURCE side of the cable to the back of the AC source and the PC side of the cable to the PC port.

Resolution for Symptom 1

The P and RP Series of AC sources require hardware handshaking to control data flow from the PC to the AC source. After receiving a command, the AC source asserts the DTR line to hold off further communication from the PC until the command just sent has been processed. Under Windows 95, it is possible to use a 16 byte transmit buffer if a 16550 UART is present. This FIFO exceeds the length of most AC source commands. When enabled, this mode may result in more than one command being placed in the UART output buffer. If this happens, the handshake from the AC source will not prevent the content of this buffer being sent to the AC source and thus will result in more than one command being sent to the AC source.

To resolve this problem, the UART FIFO length needs to be reduced or disabled altogether. The procedure to disabled the FIFO mode is outlined in the next paragraph.

Note: If turning off the UART FIFO conflicts with other applications that need to run on the same PC using the same COM port, this solution may not be acceptable. In this case, skip this step and proceed to the second symptom resolution which relies on a software implemented hold-off instead of turning off the FIFO buffer. If you are using Windows 3.1 and experience the same problem, the latter method is the only resolution available to you so you should skip the next paragraph as well.

Procedure

1. Make sure the PGUI program is closed and no device is using the com port in use.
2. From the Windows 95 desktop, right click on the "My Computer" icon which is located in the top left corner of the screen.
3. From the popup menu, select the "Properties" entry.
4. This brings up the System Properties dialog box
5. From the tabs shown at the top of the dialog box, select the "Device Manager" tab.
6. The relevant screen is shown in Figure 9-1.
7. Expand the Ports(COM&LPT) tree selection by clicking on the '+' sign
8. Select the COM port you plan to use to communicate with the P or RP series power source.
9. With the correct COM port selected, click on the Properties button at the bottom left of the dialog box.
10. This brings up the settings dialog box for the COM port. In this example, COM2 is used.
11. From the tabs at the bottom of the dialog box, select the "Port Settings" tab.
12. This should bring up the dialog shown in Figure 9-2.

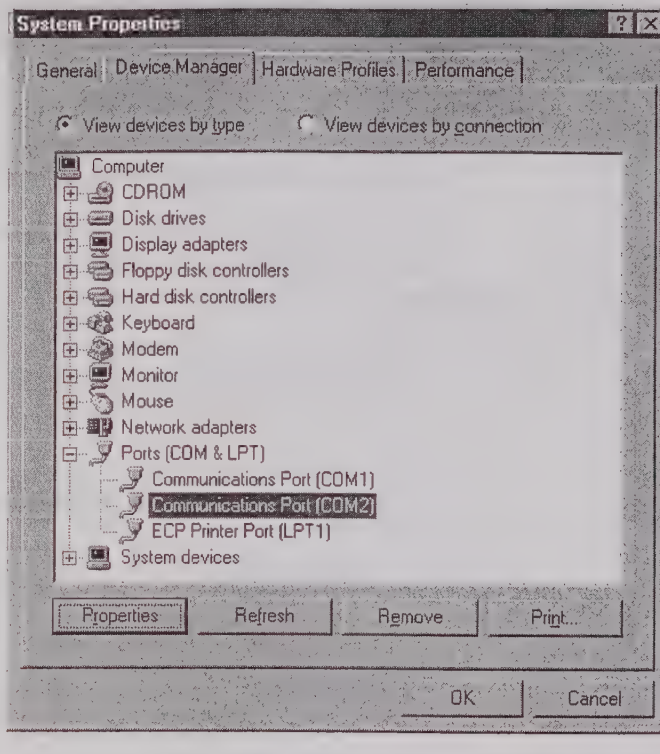


Figure 9-1: System Properties Dialog Box

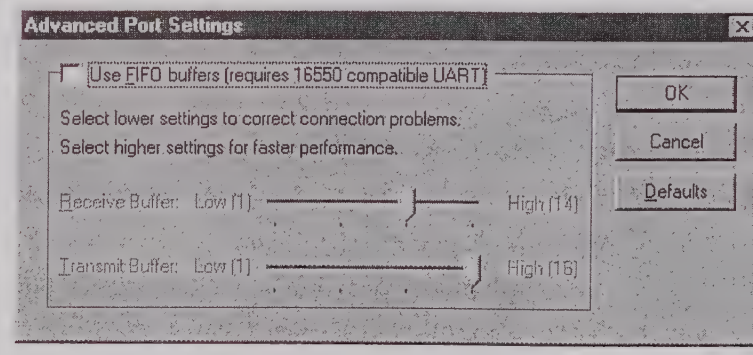


Figure 9-2: Advanced Port Settings Dialog Box

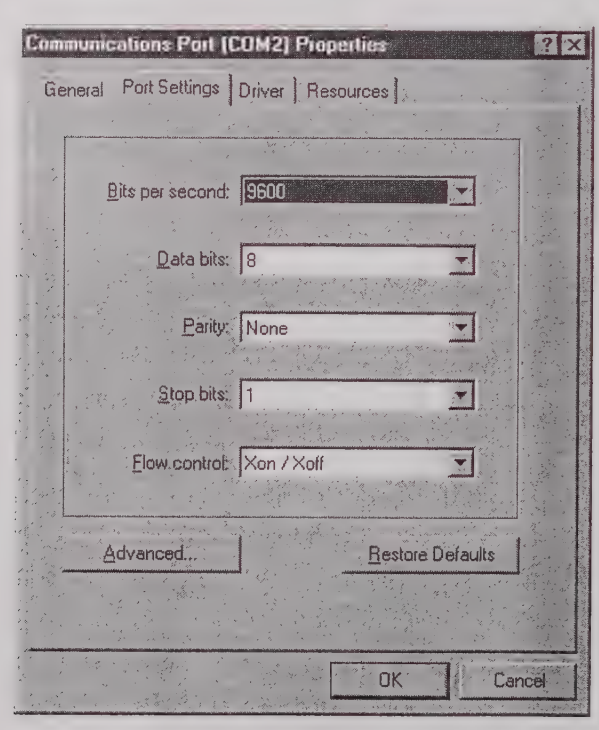


Figure 9-3: COM Port Properties Dialog Box

13. Next, select the Advanced button to bring up the advanced port settings dialog box shown in Figure 9-3.
14. At the top of the dialog box, disable the "Use FIFO buffers (requires 16550 compatible UART)" checkbox. This will bypass the UART FIFO's and enable the hardware handshake to work correctly.
15. Click on the all OK buttons to close all dialog boxes that remain open.
16. This should enable the PGUI to work correctly.

Resolution for Symptom 2

Execute the suggested procedure to resolve symptom 1 first. If an occasional error continues to occur while slewing the voltage or frequency slider controls in the PGUI program, add a command delay to the PGUI ini file using the following procedure. This symptom may occur on some PC's.

Procedure

1. Close the PGUI program if it is still open.
2. Use the Windows Explorer and select the PGUI directory or the directory into which you installed the PGUI program.
3. Locate the PGUI.INI file (Type = Configuration Settings).
4. Open the PGUI.INI file using a text editor such as Notepad.
5. Locate the [Interface] section and find the entry called "CmdDelay". If no such entry is present add it yourself.
6. The default value for the CmdDelay is set to 0. Change this value to 10.
7. Your PGUI.INI file should look like this now:

```
[Interface]
Bus=0
CommPort=2
GPIBDriver=0
ACSourceAddress=1
CmdDelay=10


[PowerSource]
Model_number=0


[WindowState]
Top=5272
Left=6112
Height=4815
Width=6975
```

8. Save the file using the File, Save menu.
9. Close Notepad and start the PGUI.
10. Try to connect again. You may have to cycle the power on the AC source if it still shows the Err -100 display.

Higher values than 10 may be set for the CmdDelay parameter if this fix does not resolve your problem.

9.5. Installed Files

The installation program will install the following files in the directories specified. Note that files with the same name that already exists in these directories will not be overwritten as part of the installation process. If older files of the same name are found, they will be replaced. If you need to retain a copy of these older version files, we recommend you back these files up prior to running the installation program.

9.5.1. PGUI Distribution Files

Application directory files:

The following files are copied to the application directory. The application directory name is chosen by the user at the time of installation. In this manual, the default application directory name PGUI is used.

path and filename

.\PGUI\PGUI.exe

.\PGUI\PGUI.hlp

Windows system directory files:

The following support files are copied to the windows system directory:

path and filename

.\windows\system\gsw.exe

.\windows\system\fpgrid10.vbx

.\windows\system\cmdialog.vbx

.\windows\system\spin.vbx

.\windows\system\threed.vbx

.\windows\system\mhtip.vbx

.\windows\system\graph.vbx

.\windows\system\mscomm.vbx

.\windows\system\mhrun400.ddl

.\windows\system\commdlg.ddl

.\windows\system\vbrun300.ddl

9.5.2. PGUI32 Distribution files

Application directory files

The following files are copied to the application directory. The application directory name is chosen by the user during the installation process. The default directory for the PGUI32 is:

C:\Program Files\California Instruments\PGUI32

Pgui32.exe	Executable
Pgui32.hlp	On Line Help file
Pgui32.cnt	Help Contents file

Windows System directory files

The following shared files are stored in the Windows\System directory during installation:

Mscomm32.ocx	Microsoft Serial communications active control
ss32x25.ocx	Grid spreadsheet active control
Comdlg32.ocx	Microsoft Common dialog active control
Comctl32.ocx	Microsoft Common controls
Msvbvm50.dll	Microsoft Visual Basic 5.0 virtual machine library

Note: The location of these files as well as the files themselves may change with future versions of the PGUI32. Consult the included readme file for last minute program information.

9.6. Software Registration

We encourage you to send in the software end-user registration form located on the next page. Only registered users will be informed of software updates and bug fixes that may be released from time to time. Please mail the completed end-user registration form to the following address :

California Instruments Corporation
Attn: Customer Satisfaction Department
9689 Towne Centre Drive
San Diego CA 92121-1964
U.S.A.

You can also fax a copy of the form to the fax number listed below:

(858) 677-0940

(Please specify "Customer Satisfaction Department" on your fax cover page.)

California Instruments Corporation
Software End-user Registration Form

Complete and submit to:
California Instruments Corporation
Attn: Customer Satisfaction Department
9689 Towne Centre Drive
San Diego CA 92121
United States of America

End-user information

Company _____ Division _____
Contact _____ Title _____
Department _____
Address _____ Mailstop _____
City _____ State _____ Zip _____
Phone ____-_____ Fax ____-_____
E-Mail _____@_____

Software revision:

PGUI PGUI32

Program CI RP-Series AC Source Graphical User Interface
Version_____
Rel Date ___ / ___ / 19___

Company use only:

Date received : Receipt acknowledgment sent : yes / no
Updated version sent : ___ / ___ / 19___ Processed by :_____

CI-SWRF August - 1998

10. Top Assembly Replaceable parts

Table 10: Replaceable Parts

SEQ#	C.I.PART #	DESCRIPTION	QTY.
1251RP TOP ASSEMBLY (5003-400-1)			
A1	5003-401-1	HEATSINK ASSEMBLY, DC-DC	1
A2	5003-402-1	HEATSINK ASSEMBLY, DC-AC/ PFC	1
A4	5003-700-1	PC ASSEMBLY, OSCILLATOR	1
*A5	5003-701-1	PC ASSEMBLY, RS232 / IEEE 488	1
B1/B2	241187	FAN, 3" 24 VDC	1
F1	270167	FUSE, 15A, 250V, 60Hz	1
J1	410666	CONNECTOR,RCPT,3 PIN, PWR INPUT	1
J2	410665	CONNECTOR,AC,RCPT,125V, SINGLE	1
J3	410589	CONNECTOR,RCPT,3 SOC,EUROPEAN	1
S1	240562	SWITCH,ROCKER, DPST	1
XF1	250587	FUSE HOLDER, CHASSIS	1
	250596	FUSE CARRIER,1-1/4" x 1/4	1

*** OPTIONAL**

Contact California Instruments for replacement parts.

page intentionally left blank

11. Programming Information

This manual contains programming information for the RP Series AC Power Source. You will find the following information in the rest of this guide:

Chapter 12	Introduction to SCPI
Chapter 13	System Considerations
Chapter 14	SCPI Command Reference
Chapter 15	Programming Examples
Chapter 16	Status Registers
Appendix A	SCPI command tree
Appendix B	SCPI conformance information
Appendix C	Error messages

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12. Introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) is a programming language for controlling instrument functions over the RS232 or IEEE 488 bus. The same SCPI commands and parameters control the same functions in different classes of instruments. For example, you would use the same MEAS:VOLT? command to measure the AC source output voltage or the output voltage of a SCPI-compatible multimeter.

12.1. Conventions Used in This Manual

Angle brackets<>	Items within angle brackets are parameter abbreviations. For example, <NR1> indicates a specific form of numerical data.
Vertical bar	Vertical bars separate alternative parameters. For example, 0 | 1 indicates that either "0" or "1" can be used as a parameter.
Square Brackets[]	Items within square brackets are optional. The representation [SOURce:]VOLT means that SOURce: may be omitted.
Boldface font	Boldface font is used to emphasize syntax in command definitions. CURR <NRf> shows a command definition.
Upper case font	Upper case font is used to show program lines in text. OUTP 1 shows a program line.

12.2. The SCPI Commands and Messages

This paragraph explains the syntax difference between SCPI Commands and SCPI messages.

12.2.1.Types of SCPI Commands

SCPI has two types of commands, common and subsystem.

- Common commands are generally not related to specific operations but to controlling overall AC source functions such as reset, status and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk:

  *RST *IDN? *SRE 255

- Subsystem commands perform specific AC source functions. They are organized into an inverted tree structure with the "root" at the top. Some are single commands while others are grouped within specific subsystems. **You must include the root header in all commands sent to the AC source.**

Refer to appendix A for the AC source SCPI tree structure.

12.2.2.Types of SCPI Messages

There are two types of SCPI messages, program and response.

- A program message consists of one or more properly formatted SCPI commands sent from the controller to the AC source. The message, which may be sent at any time, requests the AC source to perform some action.

- A response message consists of data in a specific SCPI format sent from the AC source to the controller. The AC source sends the message only when commanded by a program message called a "query."

12.2.3.The SCPI Command Tree

As previously explained, the basic SCPI communication method involves sending one or more properly formatted commands from the SCPI command tree to the instrument as program messages. The following figure shows a portion of a subsystem command tree, from which you access the commands located along the various paths (you can see the complete tree in appendix A).

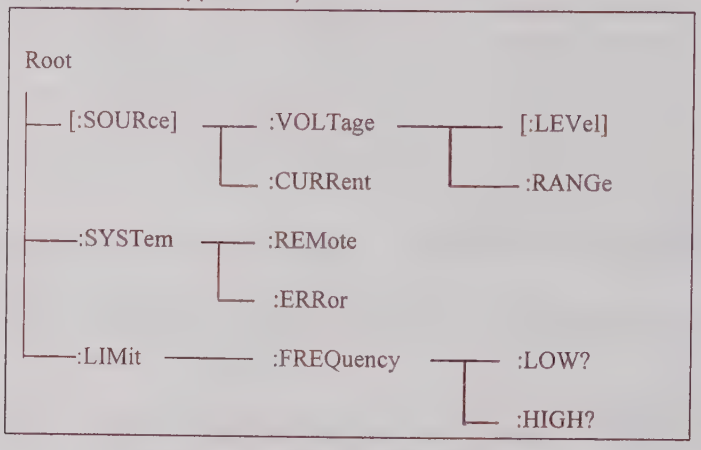


Figure 12-1: Partial Command Tree

The Root Level

Note the location of the ROOT node at the top of the tree. Commands at the root level are at the top level of the command tree. The SCPI interface is at this location when:

- the AC source is powered on
- a device clear (DCL) is sent to the AC source
- the SCPI interface encounters a message terminator
- the SCPI interface encounters a root specifier

Active Header Path

In order to properly traverse the command tree, you must understand the concept of the active header path. When the AC source is turned on (or under any of the other conditions listed above), the active path is at the root. That means the SCPI interface is ready to accept any command at the root level, such as SOURCe or MEASurement.

If you enter SOURCe the active header path moves one colon to the right. The interface is now ready to accept :VOLTage :FREQuency, or :CURRent as the next header. You must include the colon, because it is required between headers.

If you now enter :VOLTage, the active path again moves one colon to the right. The interface is now ready to accept either :RANGe or :LEVel as the next header.

If you now enter :RANGe you have reached the end of the command string. The active header path remains at :RANGe If you wished, you could have entered :RANGe 136 ;LEVel 115 and it would be accepted as a compound message consisting of:

1. SOUR:VOLT:RANG 136.

2. SOUR:VOLT:LEV 115.

The entire message would be:

SOUR:VOLT:RANG 136;LEV 115.

The message terminator after LEVel 115 returns the path to the root.

Note: The RP Series interface buffer is limited to 21 characters, however. As such, compound commands are not recommended as they often exceed this message length limit.

Moving Among Subsystems

In order to combine commands from different subsystems, you need to be able to restore the active path to the root. You do this with the root specifier (:). For example, you could set the output frequency to 60 Hz and set the display mode to frequency.

FREQ 60

DISP:MODE 0

Because the root specifier resets the command parser to the root, you can use the root specifier and do the same thing in one message:

FREQ 60;:DISP:MODE 0

Including Common Commands

You can combine common commands with system commands in the same message. Treat the common command as a message unit by separating it with a semicolon (the message unit separator). Common commands do not affect the active header path; you may insert them anywhere in the message.

VOLTage 115;*ESE 255

OUTPut 0;*RCL 2

12.3. Using Queries

Observe the following precautions with queries:

- Set up the proper number of variables for the returned data.
- Read back all the results of a query before sending another command to the AC source. Otherwise a Query Error will occur and the unreturned data will be lost.

12.4. Structure of a SCPI Message

SCPI messages consist of one or more message units ending in a message terminator. The terminator is not part of the syntax, but implicit in the way your programming language indicates the end of a line (such as a newline or end-of-line character).

12.4.1.The Message Unit

The simplest SCPI command is a single message unit consisting of a command header (or keyword) followed by a message terminator.

FREQuency?<newline>

VOLTage?<newline>

The message unit may include a parameter after the header. The parameter usually is numeric:

VOLTage 20<newline>

OUTPut 1<newline>

12.4.2. Combining Message Units

The following command message is briefly described here, with details in subsequent paragraphs.

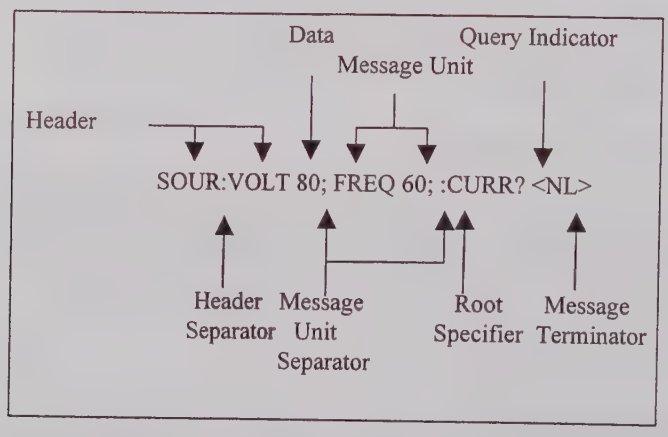


Figure 12-2: Command Message Structure

The basic parts of the above message are:

Message Component	Example
Headers	SOURC VOLT FREQ CURR
Header Separator	The colon in SOUR:VOLT
Data	80 60
Data Separator	The space in VOLT 80 and FREQ 60
Message Units	VOLT 80 FREQ 60 CURR?
Message Unit Separator	The semicolons in VOLT 80; and FREQ 60;
Root Specifier	The colon in :CURR?
Query Indicator	The question mark in CURR?
Message Terminator	The <NL> (newline) indicator. Terminators are not part of the SCPI syntax

Note: The use of compound messages such as the one shown in Figure 12-2 is not recommended as they typically exceed the available receive buffer length of the RP Series interface.

12.4.3. Headers

Headers are instructions recognized by the AC source. Headers (which are sometimes known as "keywords") may be either in the long form or the short form.

Long Form The header is completely spelled out, such as VOLTAGE, SYSTEM, and OUTPUT.

Short Form The header has only the first three or four letters, such as VOLT, SYST, and OUTP.

The SCPI interface is not sensitive to case. It will recognize any case mixture, such as VOLTAGE, VOLTage,Voltage. Short form headers result in faster program execution.

In view of the 21 character receive buffer size of the RP Series, the short form is recommended under all circumstances.

Header Convention

In the command descriptions in chapter 14 of this manual, headers are emphasized with boldface type. The proper short form is shown in upper-case letters, such as DELay.

Header Separator

If a command has more than one header, you must separate them with a colon (SYSTem:ERRor LIMit:FREQuency:LOW).

Optional Headers

The use of some headers is optional. Optional headers are shown in brackets, such as VOLTage[:LEVel] 100.

12.4.4.Query Indicator

Following a header with a question mark turns it into a query (VOLTage?, VRANGe?).

12.4.5.Message Unit Separator

When two or more message units are combined into a compound message, separate the units with a semicolon (VOLT 100;FREQ 60).

12.4.6.Root Specifier

When it precedes the first header of a message unit, the colon becomes the root specifier. It tells the command parser that this is the root or the top node of the command tree. Note the difference between root specifiers and header separators in the following examples:

SOURce:VOLTage:LEVel 100	All colons are header separators
:SOURce:VOLTage:LEVel 100	Only the first colon is a root specifier
SOURce:VOLTage:LEVel 100;:FREQuency 55	Only the third colon is a root specifier

You do not have to precede root-level commands with a colon; there is an implied colon in front of every root-level command.

12.4.7.Message Terminator

A terminator informs SCPI that it has reached the end of a message. The only permitted message terminator is:

- newline (<NL>), which is ASCII decimal 10 or hex 0A.

In the examples of this manual, there is an assumed message terminator at the end of each message. If the terminator needs to be shown, it is indicated as <NL> regardless of the actual terminator character.

12.5. SCPI Data Formats

All data programmed to or returned from the AC source is in ASCII. The data type may be numerical or character string.

12.5.1.Numerical Data Formats

Symbol	Data Form
Talking Formats	
<NR1>	Digits with an implied decimal point assumed at the right of the least-significant digit. Examples: 273
<NR2>	Digits with an explicit decimal point. Example:.0273
<NR3>	Digits with an explicit decimal point and an exponent. Example: 2.73E+2
<Bool>	Boolean Data. Example: 0 | 1
Listening Formats	
<Nrf>	Extended format that includes <NR1>, <NR2> and <NR3>. Examples: 273.2 , 2.73E2
<Bool>	Boolean Data. Example: 0 | 1

12.5.2.Character Data

Character strings returned by query statements may take either of the following forms, depending on the length of the returned string:

<CRD> Character Response Data. Permits the return of character strings.

<AARD> Arbitrary ASCII Response Data. Permits the return of undelimited 7-bit ASCII. This data type has an implied message terminator.

<SRD> String Response Data. Returns string parameters enclosed in double quotes.

page intentionally left blank

13. System Considerations

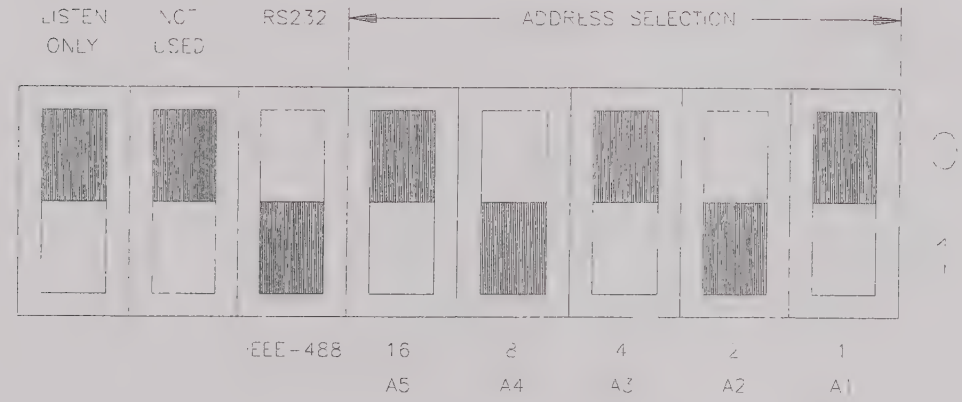
This chapter addresses some system issues concerning programming.

13.1. IEEE Interface

The 801RP/1251RP can optionally be equipped with both RS232C and IEEE-488 interfaces. The desired interface is selected by moving the dip switch position 5 to the correct mode. Only one interface can be active at a time.

13.1.1.IEEE address selection

The IEEE address of the 801RP/1251RP is set using the dip switch at the rear of the unit. Switch position 4 through 0 corresponds to bits 4 through 0 of the IEEE address. See table below.



- The black section represents the switches.
- The above configuration would cause the 801RP/1251RP to be in GPIB mode at address 10.
- Listen only must be in the up position to work properly.

Note: Switch setting changes do not take effect until power is cycled.

13.2. RS232C Interface

A suitable cable to connect the 801RP/1251RP AC Source to a 9 pin PC-AT style serial port is supplied with the source. If you are unable to locate this cable, you need to use a cable that conforms to the wiring diagram shown in Figure 13-1.

13.2.1.Serial Communication test program

The following sample program written in Quick-BASIC can be used to check communication to the RP Series AC source over the RS232C serial interface. The interface is optional and must be installed for this to work.

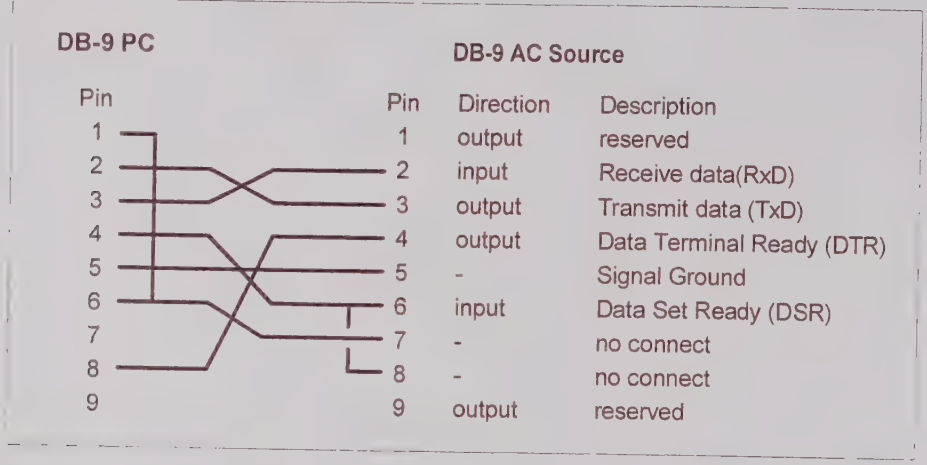
```
'California Instruments P Series RS232C Communication Demo Program
'(c) 1996 Copyright California Instruments, All Rights Reserved
'
'This program is for demonstration purposes only and is not to be
'used for any commercial application
'================================================================
'Function and Subroutine Declarations
DECLARE FUNCTION retstring$ ()

'================================================================
'MAIN PROGRAM CODE
'================================================================

'OPEN COM2. Replace with COM1, COM3 or COM4 for Com port used
'The input and output buffers are set to 2K each although
'this is not required for most operations.

OPEN "COM2:9600,n,8,1,BIN,LF,TB2048,RB2048" FOR RANDOM AS #1 LEN = 1
CLS
PRINT "**** P SERIES INTERACTIVE MODE ****"
'Enter and endless loop to accept user entered commands
DO
  INPUT "Enter Command ('quit' to exit)--> ", cmd$
  IF cmd$ <> "QUIT" AND cmd$ <> "quit" THEN
    IF LEN(cmd$) > 0 THEN
      PRINT #1, cmd$ + CHR$(10);
    END IF
    IF INSTR(cmd$, "?") THEN
      PRINT "AC Source response = " + retstring$
    END IF
    'Check for Errors after each command is issued
    PRINT #1, "*ESR?" + CHR$(10);
    'Mask off bits 5,4,3,2 only. Other bits are not used.
    esr% = VAL(retstring$) AND 60
    'Process esr% value for error bits
    IF esr% AND 4 THEN
      PRINT "*** Query Error Reported by AC Source ***"
    END IF
    IF esr% AND 8 THEN
      PRINT "*** Instrument Dependent Error Reported by AC Source ***"
    END IF
    IF esr% AND 16 THEN
      PRINT "*** Command Execution Error Reported by AC Source ***"
    END IF
    IF esr% AND 32 THEN
      PRINT "*** Command Syntax Error Reported by AC Source ***"
    END IF
    'Clear ERR. -XXX Message from front panel if any error occured
    IF esr% <> 0 THEN
      PRINT #1, "*CLS" + CHR$(10);
    END IF
  END IF
LOOP UNTIL cmd$ = "QUIT" OR cmd$ = "quit"
'Close COM port on exit
CLOSE #1
END

'================================================================

FUNCTION retstring$
  'This function returns a response string from the P Series
  'AC power source. The QBasic statement LINE INPUT cannot be used
  'as the P Series does not return a CR <13> after a response
  'message. The LINE INPUT function waits for a CR before
  'returning a string. The P Series returns a LF <10> instead
  'so we need to poll each returned character for a LF to
```

```
  'assemble the response string. The COM port needs to be
  'opened AS random with a record length of 1 for it to support
  'this function. Also, the device number is assumed to be #1
  'Optionally, this value could be passed as a parameter to
  'make this program more generic.

  DIM char AS STRING * 1
  DIM resp AS STRING
  char = ""
  resp = ""
  DO
    char = INPUT$(1, #1)
    resp = resp + char
  LOOP UNTIL char = CHR$(10)
  'Return result
  retstring = LEFT$(resp, LEN(resp) - 1)

END FUNCTION
```

13.2.2. Serial Cable Diagram

The following wiring diagram is required for the serial interface cable between the RP Series AC power source and a PC communications port connector.

Figure 13-1: RS232C Interface cable wiring diagram



14. SCPI Command Reference

14.1. Introduction

Related Commands

Where appropriate, related commands or queries are included. These are listed because they are either directly related by function, or because reading about them will clarify or enhance your understanding of the original command or query.

This chapter is organized as follows:

- Subsystem commands, arranged by subsystem
- IEEE 488.2 common commands

14.2. Subsystem Commands

Subsystem commands are specific to AC source functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. The description of common commands follows the description of the subsystem commands.

The subsystem command groups are listed in alphabetical order and the commands within each subsystem are grouped alphabetically under the subsystem. Commands followed by a question mark (?) take only the query form. When commands take both the command and query form, this is noted in the syntax descriptions.

14.2.1.Measurement Subsystem

This subsystem programs the current and voltage measurement capability of the RP Series AC source.

Subsystem Syntax

```
:MEASure
    :CURRent?        Returns the rms value of current
    :VOLTage?        Returns the rms value of voltage
```

MEASure:CURRent?

This query returns the rms value of the output AC current being sourced at the output terminals. Note that the output relay must be closed to obtain current flow.

Query Syntax	MEASure:CURRent?
Parameters	None
Examples	MEAS:CURR?
Returned Parameters	<NR2>
Related Commands	OUTP 0 | 1

MEASure:VOLTage?

This query returns the AC rms voltage being sourced at the output terminals. Note that the output relay must be closed or 0 volts will exist at the terminals.

Query Syntax	MEASure:VOLTage?
Parameters	None
Examples	MEAS:VOLT?
Returned Parameters	<NR2>
Related Commands	OUTP 0 | 1

14.2.2. Source Subsystem

This subsystem programs all the output parameters of the RP Series AC source.

Subsystem Syntax

[SOURce:]	
CURRent:	Set the rms current limit in amps.
VOLTage:	
[LEVel]	Set the rms output voltage value in volts.
RANGe:	Set the output voltage range.
FREQuency:	Set the output frequency value in Hz.

CURRent

This command sets the rms current limit of the output. If the output current exceeds this limit, the output latches into a disabled state when current limiting occurs. The output voltage programming is reset to zero when this condition occurs and the output relay state is set to OFF.

Note that the CURRent command is coupled with the VRANGe. This means that the maximum current limit that can be programmed at a given time depends on the voltage range setting in which the unit is presently operating.

Command Syntax	[SOURce:]CURRent <NRf>
Parameters	0 to a value specified by the LIM:CURR
Unit	A (rms amperes)
*RST	Defined by the PON
Examples	CURR 5
Query Syntax	CURRent?
Returned Parameters	<NR2>
Related Commands	VOLT:RANG

FREQuency

This command sets the frequency of the output sinewave.

Command Syntax	[SOURce:]FREQuency <NRf+>
Parameters	range specified by the LIM:FREQ:LOW and LIM:FREQ:HIGH commands
Unit	Hz (Hertz)
*RST Value	defined by PON
Examples	FREQ 50
Query Syntax	FREQuency?
Returned Parameters	<NR2>
Related Commands	LIM:FREQ;LOW? LIM:FREQ:HIGH?

VOLTage

This command programs the AC rms output voltage level of the power source.

Command Syntax	[SOURce:]VOLTage[:LEVel] <NRf+>
Parameters	0 to maximum voltage range specified by the VRAN command
Unit	V (rms voltage)
*RST Value	0 volt
Examples	VOLT 250 VOLT:LEV 25
Query Syntax	[SOURce:]VOLTage[:LEVel]?
Returned Parameters	<NR2>
Related Commands	VOLT:RANGe

RANGe

This command sets the voltage range of the power source . Two voltage ranges are available: a 135 volt range and a 270 volt range. However, to allow this voltage to be present at the load, the AC source allows voltage settings slightly higher than this. This allows for one or two volt of cable loss. Consequently, the actual voltage range values will be slightly higher than 135 and 270. To determine the actual range values, use the query format of the RANGE command. The returned values for high and low range (eg. 136 and 272) should be used to change range. In any case, the high voltage range value will be two times the low voltage range value. Sending a parameter other than the actual range values will not be accepted. Some RP Series may use other voltage range values than shown here. It is recommended to query the actual range values using the LIM:VOLT? query as part of your application program.

When the range is set to 136, the maximum rms voltage that can be programmed is 136 volts.

The VRANGe command is coupled with the CURRent command. This means that the maximum current limit that can be programmed at a given time depends on the voltage range setting in which the unit is presently operating.

Command Syntax	[SOURce:]VOLTage:RANGe<NRf+>
Parameters	136 | 272
*RST Value	defined by the PONS
Examples	VOLT:RANG 136
Query Syntax	VOLT:RANGe?
Returned Parameters	<NR2>
Related Commands	VOLT LIM:VOLT?

14.2.3.Output Subsystem

This subsystem controls the main output function of the RP Series source.

Subsystem Syntax

OUTPut <bool> Enable/disable output voltage, current, power, etc.

OUTPut

Command Syntax	OUTPut <bool>	
Parameters	0 | 1	
*RST Value	OFF	
Examples	OUTP 1	OUTP: ON
Query Syntax	OUTPut?	
Returned Parameters	0 | 1	
Related Commands	*RCL *SAV	

14.2.4.Limit Subsystem

This subsystem controls the voltage frequency and current limit of the power source. These limits are set at the factory and depend on the power source rating. It is not accessible by the user. The query format is accessible however.

Subsystem Syntax

```
LIMit:
    FREQuency:
        LOW?      Queries the lower frequency limit
        HIGH?     Queries the upper frequency limit
    VOLTage?      Queries the upper voltage limit
    CURRent?      Queries the upper current limit
```

LIMit:FREQuency:LOW?

This command queries the lower frequency limit of the power source.

Command Syntax	LIMit:FREQuency:LOW <NRf>
Parameters	Low freq limit [command protected]
Query Syntax	LIMit:FREQuency:LOW?
Returned Parameters	<NR2>

LIMit:FREQuency:HIGH?

This command queries the upper frequency limit of the power source.

Command Syntax	LIMit:FREQuency:HIGH <NRf>
Parameters	High freq limit [command protected]
Query Syntax	LIMit:FREQuency:HIGH?
Returned Parameters	<NR2>

LIMit:CURRent?

This command queries the maximum current limit the power source will operate at in the low voltage range.

Command Syntax	[SOURce:]LIMit:CURRent <NRf>
Parameters	maximum current limit at low voltage range [command protected]
Query Syntax	LIMit:CURRent?
Returned Parameters	<NR2>

LIMit:VOLTage?

This command queries the maximum voltage the power source will operate at in the high voltage range.

Command Syntax	LIMit:VOLTage<NRf>
Parameters	maximum voltage available in high voltage range [command protected]
Query Syntax	LIMit:VOLTage?
Returned Parameters	<NR2>

14.2.5.Display Subsystem

DISPlay:MODE

This command is used to control the AC source display. The command will allow the Frequency/Current display to switch between display of current or frequency data.

Command Syntax	DISPlay:MODE <boolean>
Parameters	0 display frequency, 1 display current
Query Syntax	DISPlay:MODE <boolean>?
Returned Parameters	<NR2>

14.3. System Commands

The system commands control the system level functions of the AC Source.

14.3.1. System syntax Command

Subsystem Syntax

SYSTem:

ERRor?	Returns the error number and error string
LOCal	Go to local mode
REMote	Go to remote mode
PON	Define the power on register number

SYSTem:ERRor?

This query returns the next error number followed by its corresponding error message string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns 0,"No Error". If more errors are accumulated than the queue can hold, the last error in the queue is -350,"Too Many Errors".

Query Syntax	SYSTem:ERRor?
Parameters	None
Returned Parameters	<NR1>,<SRD>
Example	SYST:ERR?

SYSTem:LOCal

This command sets the interface in Local state, which enables the front panel controls. This command only applies to the RS232C interface. If IEEE 488 is used, the remote/local state is determined by the REN line on the IEEE 488 interface.

Command Syntax	SYSTem:LOCal
Parameters	None
Example	SYST:LOC
Related Commands	SYST:REM

SYSTem:REMote

This command sets the interface in the Remote state, which disables all front panel controls. This command only applies to the RS232C interface. If IEEE 488 is used, the remote/local status is determined by the REN line on the IEEE 488 interface.

Command Syntax	SYSTem:REMote
Parameters	None
Example	SYST:REM
Related Commands	SYST:LOC

SYSTem:PON

This command is used to define the register value the power source will use to initialize its parameters at power up. If data in the selected register is not valid or the selected register is 8, the initialization will be with factory default values. Refer to paragraph 14.4.6.

Command Syntax	SYSTem:PON <NRf+>
Parameters	0 to 8
Examples	SYST:PON 1
Query Syntax	SYST:PON?
Returned Parameters	<NR1>
Related Commands	*SAV

14.4. Common Commands

Common commands begin with an * and consist of three letters (command) or three letters and a ? (query). Common commands are defined by the IEEE 488.2 standard to perform some common interface functions. The power source responds to the required common commands that control status reporting, synchronization, and internal operations. RP Series units also respond to optional common commands that control stored operating parameters.

Common commands and queries are listed alphabetically. If a command has a corresponding query that simply returns the data or status specified by the command, then both command and query are included under the explanation for the command. If a query does not have a corresponding command or is functionally different from the command, then the query is listed separately. The description for each common command or query specifies any status registers affected. Refer to Chapter 16 which explains how to read specific register bits and use the information that they return.

Common Commands Syntax

*CLS	Clear status
*ESE <n>	Standard event status enable
*ESE?	Return standard event status enable
*ESR?	Return event status register
*IDN?	Return instrument identification
*RCL <n>	Recall instrument state
*RST	Reset
*SAV <n>	Save instrument state
*SRE <n>	Set service request enable register
*SRE?	Return service request enable register
*STB?	Return status byte

14.4.1.*CLS

This command clears the following registers (see chapter 16 for descriptions of all status registers):

- Standard Event Status
- Status Byte
- Error Queue

Command Syntax	*CLS
Parameters	None

14.4.2.*ESE

This command programs the Standard Event Status Enable register bits. The programming determines which events of the Standard Event Status Event register (see *ESR?) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A "1" in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Enable Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set. See Section 16 for descriptions of the Standard Event Status registers.

The query reads the Standard Event Status Enable register.

Table 11: Bit configuration of standard event status enable register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	not used	CME	EXE	DDE	QYE	not used	not used
Bit Weight	128		32	16	8	4		

CME	Command error	DDE	Device-dependent error
EXE	Execution error	QYE	Query error
PON	Power-on		

Command Syntax	*ESE <NRf>
Parameters	0 - 255
Power-On Value	128
Example	*ESE 129
Query Syntax	*ESE?
Returned Parameters	<NR1>(Register value)
Related Commands	*ESR? *STB?

14.4.3.*ESR?

This query reads the Standard Event Status register. Reading the register clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (see *ESE).

Query Syntax	*ESR?
Parameters	None
Returned Parameters	<NR1>(Register value)
Related Commands	*CLS *ESE *ESE?

If the *ESR? returns the value of the status bits in the ESR register. Refer to Table 12 for the status bits and their meaning.

Table 12: Bit configuration of standard event status register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	not used	CME	EXE	DDE	QYE	not used	not used
Bit Weight	128		32	16	8	4		

CME	Command error	DDE	Device-dependent error
EXE	Execution error	QYE	Query error
PON	Power-on		

14.4.4.*IDN?

This query requests the source to identify itself. It returns the data in four fields separated by commas.

Query Syntax	*IDN?	
Returned Parameters	<AARD>	
	Field	Information
	CI	Manufacturer
	xxxxxx	Model number and letter
	nnnnnn	Serial number or 0
	Rev. x.x	Revision level of firmware
Example	"CI,1251P,S123,Rev 1.0"	

Note: ***The 801RP/1251RP responds to a *IDN? query with model number 1251P. This is normal and should be interpreted as a 801RP/1251RP. There are no functional differences between the 1251P and 801RP/1251RP with respect to remote control.***

14.4.5.*RCL

This command restores the AC source to a state that was previously stored in memory with a *SAV command to the specified location. All states are recalled with the following exceptions:

- DISPlay:MODE

Command Syntax	*RCL <NRf>
Parameters	0 through 7
Example	*RCL 3
Related Commands	*RST *SAV

WARNING: ***Recalling a previously stored state may place hazardous voltages at the AC source output.***

14.4.6.*RST

This command resets the AC source to a setting defined by the values in the register defined by PON if valid or by the following factory-defined states:

Table 13: *RST default parameter values

Item	Value	Item	Value
VOLT	0V	FREQ	60 HZ
CURR	Note	VOLT:RANGe	136V
OUTP	0 (OFF)	DISP:MODE	0 (FREQ)

Note: For 1251RP: 9.2A For 801RP: 6A

Command Syntax	*RST
Parameters	None
Related Commands	*SAV

Table 14: Status register power on condition

Register	Status on Power On	Status after *RST
- ESE register	All 0's	All 0's
- ESR register	PON bit = 1, all others 0	PON = 0, all others unaffected
- STB register	All 0's	All 0's
- SRE register	All 0's	All 0's

14.4.7.*SAV

This command stores the present state of the AC source to a specified location in memory. Up to 8 states can be stored in nonvolatile memory.

Command Syntax	*SAV
Parameters	0 through 7
Related Commands	*RCL *RST

14.4.8.*SRE

This command sets the condition of the Service Request Enable Register. This register determines which bits from the Status Byte Register (see *STB for its bit configuration) are allowed to set the Master Status Summary (MSS). A 1 in any Service Request Enable Register bit position enables the corresponding Status Byte Register bit and all such enabled bits then are logically ORed to cause Bit 6 of the Status Byte Register to be set. See chapter 16 for more details concerning this process.

When the controller conducts a STB? command, the MSS bit is not cleared. When *SRE is cleared (by programming it with 0), the source cannot generate an MSS bit.

Command Syntax	*SRE <NRf>
Parameters	0 to 255
Default Value	128
Example	*SRE 255
Query Syntax	*SRE?
Returned Parameters	<NR1>(Register binary value)
Related Commands	*ESE *ESR

14.4.9.*STB?

This query reads the Status Byte register, which contains the status summary bits and the Output Queue MAV bit. Reading the Status Byte register does not clear it. The input summary bits are cleared when the appropriate event registers are read (see Section 16 for more information).

Table 15: Bit Configuration of Status Byte Register

Bit Position	7	6	5	4	3	2 - 0
Bit Name	OPER	MSS	ESB	MAV	QUES	not used
Bit Weight	128	64	32	16	8	

OPER	operation status summary	MSS	master status summary
ESB	event status byte summary		
QUES	questionable status summary	MAV	message available

Query Syntax	*STB?
Returned Parameters	<NR1> (Register binary value)

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15. Programming Examples

15.1. Introduction

This chapter contains examples on how to program the AC source. Simple examples show you how to program:

- output functions such as voltage and frequency
- measurement functions

The examples in this chapter use generic SCPI commands. See Section 12 for information about encoding the commands as language strings. Where appropriate, optional commands are shown for clarity in the examples.

15.2. Programming the Output

Power-on Initialization

When the AC source is first turned on, it wakes up with the output state defined by the PON register number. If the register number or the register has no valid data, the AC source initializes to the following state.

VOLT 0
FREQ 60
OUTP 0
VOLT:RANG 136

The following commands are given implicitly at power-on:

*RST
*CLS
*SRE 128
*ESE 0

*RST is a convenient way to program all parameters to a known state. Refer to **Error! Reference source not found.** under the *RST command in paragraph 14.4.6 to see how each programmable parameter is set by *RST.

Enabling the Output

To enable the output, use the command:

OUTPut 1

Voltage and Frequency

The AC rms output voltage is controlled with the VOLTage command. For example, to set the AC output voltage to 125 volts rms, use:

VOLTage 125

The maximum voltage that the AC source can output is limited by the rms value of the waveform. This value is defined by the LIMIT subsystem.

Voltage Ranges

The power source has two voltage ranges that are controlled by a relay. The command that controls the range is:

VOLTage:RANGe 136 | 272

When the range is set to (136), the maximum rms voltage that can be programmed is 136 volts rms, but it is only on this range that the maximum output current rating is available.

The VRANGe command is coupled with the CURRent command. This means that the maximum current limit that can be programmed at a given time depends on the voltage range setting in which the unit is presently operating.

Frequency

The output frequency is controlled with the FREQuency command. To set the output frequency to 50 Hz, use:

FREQuency 50

Current Limit

To set the rms current limit use:

CURRent <n>

where <n> is the rms current limit in amperes.

If the load attempts to draw more current than the programmed limit, The AC source is programmed to turn off its output if the rms current limit is reached.

Note: ***The CURRent command is coupled with the VOLTage:RANGe.This means that the maximum current limit that can be programmed at a given time depends on the voltage range setting in which the unit is presently operating.***

15.3. Making Measurements

The source has the capability to return current and voltage measurements.

Voltage and Current Measurements

To measure the rms voltage or current, use:

MEASure:VOLTage?

or

MEASure:CURRent?

page left intentionally blank

16. Status Registers

You can use status register programming to determine the operating condition of the AC source at any time. For example, you may program the AC source to generate an MSS bit when an event such as a current limit occurs. When the MSS bit is set, your program can then act on the event in the appropriate fashion.

Figure 16-1: AC Source Status System Model

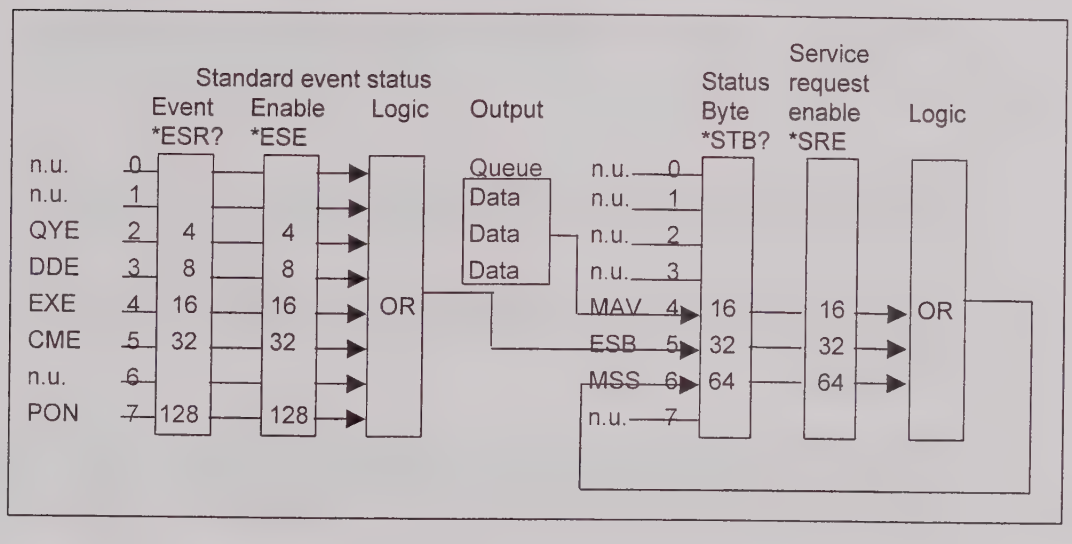


Figure 16-1 shows the status register structure of the AC source.

The Standard Event, Status Byte, and Service Request Enable registers and the Output Queue perform standard IEEE-488 functions as defined in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.

16.1. Power-On Conditions

Refer to the *RST command description in paragraph 14.4.6 for the power-on conditions of the status registers.

16.2. Standard Event Status Group

This group consists of an Event register and an Enable register that are programmed by Common commands. The Standard Event register latches events relating to interface communication status. It is a read-only register that is cleared when read. The Standard Event Enable register functions similarly to the enable registers of the Operation and Questionable status groups.

Command	Action
*ESE	programs specific bits in the Standard Event Enable register.
*ESR?	reads and clears the Standard Event register.

The PON bit in the Standard Event register is set whenever the AC source is turned on.

16.3. Status Byte Register

This register summarizes the information from all other status groups as defined in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation. The bit configuration is shown in Table 15.

Command	Action
*STB?	reads the data in the register but does not clear it (returns MSS in bit 6)

The MSS Bit

This is a real-time (unlatched) summary of all Status Byte register bits that are enabled by the Service Request Enable register. MSS is set whenever the AC source has one or more reasons for needing service. *STB? reads the MSS in bit position 6 of the response but does not clear any of the bits in the Status Byte register.

The MAV bit and Output Queue

The Output Queue is a first-in, first-out (FIFO) data register that stores AC source-to-controller messages until the controller reads them. Whenever the queue holds one or more bytes, it sets the MAV bit (bit 4) of the Status byte register.

16.4. Examples

The following section contains examples of commonly used operations involving the status registers.

You can determine the reason for an MSS bit set by the following actions:

Step 1 : Determine which summary bits are active. Use:

*STB?

Step 2 : Read the corresponding Event register for each summary bit to determine which events caused the summary bit to be set. Use:

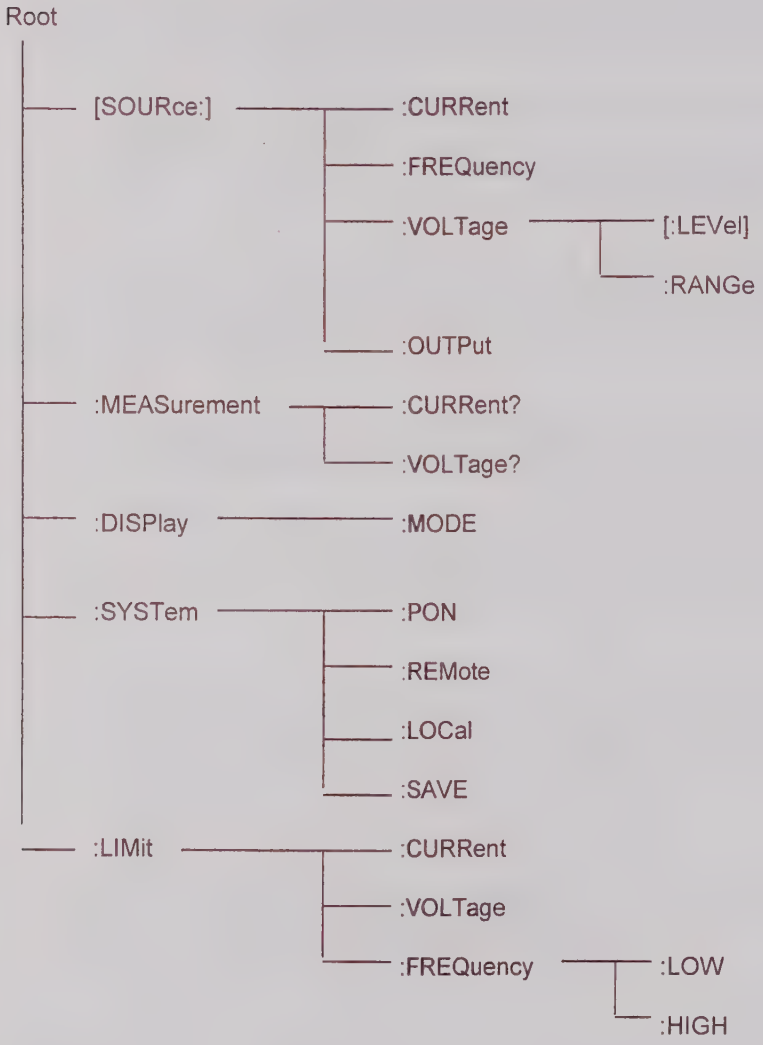
ESR?

Note: ***When an Event register is read, it is cleared. This also clears the corresponding summary bit.***

Step 3 : Remove the specific condition that caused the event. If this is not possible, the event may be disabled by programming the corresponding bit of the status group Enable.

Appendix A: SCPI Command tree

Command Syntax Tree



Appendix B: SCPI Conformance Information

SCPI Version

The RP Series AC power sources conform to SCPI version 1990.0.

Appendix C: Error Messages

Table 16: Error Messages

Error Number	Error Message String	Error Causes
0	"No error"	
-100	"Command error"	Generally the result of sending a command that uses incorrect syntax.
-200	"Execution error"	Generally the result of sending a value that is out of range, i.e., a VOLT 200 command when the unit is in the 136V (Low) range.
-300	"Device specific error"	Generally the result of an overcurrent (current limit trip) or over temperature condition.
-350	"Queue overflow"	Generally caused by too many errors being generated without reading error status, causing error buffer to overflow.
-400	"Query error"	Generally caused by sending a query followed by another command without accepting the query response first.

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